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Red Bull RB9

Adrian Newey discusses the F1 title favourite

PLUS

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Ice picks at the ready

Racing on slush is ridiculous, unpredictable and therefore utterly exhilarating

Heraclitus mentioned that you could never step into the same river twice, the water having moved on, and perhaps you too are not the person you were previously. The Andros trophy ice racing cars had the same problem, as the churning of the initially immaculate ice from the first six-car heat would turn the venue into a rutted, slushy gauntlet between the snowdrifts, sometimes changing lap to lap.

There are overdriven front wheels, locked differentials – all three of them – as the four-wheel drive, four-wheel steer spiked tyres scrabbles for grip on ice, a surface not particularly renowned for its grip level.

You have to make sure your side windows didn't mist up as they are more useful than the windscreen in this crabwise way of locomotion where cars are generally travelling sideways.

This fits in perfectly with the 'growing old is mandatory; growing up is optional' ethos.

It reminds me of a question Alexander Hamilton once asked: 'Has it not been found that momentary passions... have a more active and imperious control over human conduct than general or remote considerations of policy, utility, or justice?' Yes, that fact has been found. It has been found time and time again. The lesson of it, nevertheless, eludes us almost as rapidly.

We know that we are creatures of the passions, but we pretend that it would be possible to erase those passions and become creatures of pure reason. The racing circus tries to act serious and focused, but the bottom line is that the sheer insanity of running F1s at Monaco, or thundering through the desert in off-road racers is the main attraction.

The first sign of maturity is the discovery that the volume knob also turns to the left. That instantly disqualifies F1, tractor pulling, drag racing, endurance racing, off-road racing, Pikes Peak and rallying as grown-up pursuits, as most have the knob on 11 or even 12. Wretched excess has its attractions, after all it does touch the reptilian brain more.

'Excess on occasion is exhilarating,' said William Somerset Maugham. 'It prevents moderation from acquiring the deadening effect of a habit.'

'Moderation is a fatal thing. Nothing succeeds like excess,' offered Oscar Wilde.

The Andros trophy car certainly succeeds in that. 450hp does not seem excessive, but when it is coupled with a lightweight plastic body, minimalist spaceframe chassis, four-wheel drive through 3.5j 10/66-16 Michelin XM + S TL C50 spiked tyres in a icy winding track it does smell of overkill.

The fastest way around a hairpin on ice is actually to flick the car 180 degrees by using the four-wheel steer, in which the rears turn in the opposite direction from the fronts, enter the hairpin backwards, engine screaming at full revs and spikes churning the glassy surface, generating plumes of slush and snow through insane wheelspin, finally managing to scrabble enough traction to shoot forwards into the next straight.

Cars face off in gaggles of six, knocking two out each heat, in a short four lap barging competition, almost balletic in the side-by-side sliding through corners, occasionally bouncing off snow-banks, drivers using the four wheels, throttle, 430Nm of torque and brakes to coax the missile around the track.

Cornering, ice racing-style. Pit tech in mittens next to three-bar fire, just out of shot

Finish your heat, take the car back to the tent through the snow, and plunge into changing the settings for the next heat as track conditions always change, ruts being dug into the original pristine billiard table of ice. At some events the ice would be worn down to the original asphalt or concrete, just right for plucking the studs out of the tyre, or down to the now muddy, slushy earth if on an apposite ski slope.

Should the engineers change the amount of overdrive to the front wheels? The cam governing amount of rear lock to front? The cardioid cams that governed the rate and angle of rear steer was a simple plate with the groove channelling a pin on a simple rack, but had an infinite number of options depending on the car response, condition of the track and the number of spikes left on your tyres.

Racing tries to act serious and focused, but the sheer insanity is always the main attraction

Poring over the data was always an interesting exercise of looking into the heart of chaos. I swear I saw a Mandelbrot fractal when doing a yaw vs wheel speed plot.

Regardless of the chosen way forward, the first task is always to use the ice pick to chip away at the clogged mass of ice and slush packing the fenders, suspension and every bit of bodywork.

Thermal underwear, gloves, thick boots and the succour of hot mulled wine with cloves and raclette in the hostility unit eased the frozen feeling, and the adrenaline of getting the car out for the next inexorable heat warmed the cockles of the heart.

The 24 hours of Chamonix was the ultimate wretched excess, the heats going on all day, with the added bonus that engineers, mechanics and assorted innocent bystanders would be the passengers required in this event.

It was a magic rollercoaster ride which gave the spectator the opportunity to watch close-up the driver's antics trying to keep the car vaguely going in the right direction at maximum speed, feet tap dancing on the two stop and go pedals. It reminds me of Stirling Moss: 'If God had meant for us to walk, why did he give us feet that fit car pedals?'

The driver would twirl the steering wheel continuously, almost always managing to carom off the snow banks and accelerating even faster down the next chute. Screaming with pleasure was not unknown, while an idiotic grin was a constant throughout. Creatures of pure reason my arse.

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Responsibility in racing

Identifying potential dangers early is a must while rulebooks allow for risky tech

The concept of deliberately building driver safety into modern racing cars is a given. It wasn't always so; a big step forward in this direction was as a result of the tragic deaths of Ayrton Senna and Roland Ratzenberger at Imola in 1994.

Safety issues generally move with contemporary expectations of what is reasonable risk in most aspects of life and work, and motor racing has been no exception, if sometimes slower in acceptance and application than it should have been. From the sport's beginnings right up to the 1980s the risks were regarded as 'part of the game, old boy'.

Perhaps not surprising if one considers the carnage of the two world wars.

Teddy Mayer's quip that 'drivers are like lightbulbs – you take one out and plug in another' indicated a less than caring attitude – probably one hardened by his own brother's death while racing some years before.

This attitude persisted even to more recent times. How else does one explain the death-traps of single-seaters with the driver's feet ahead of the front wheels that became the norm for a period? What were we thinking of when making the very narrow aluminium tubs and cut-down cockpit sides allowing the cross-section of the monocoque to be as small as possible, or the pointed rollover hoops – for minimum aero drag – that simply dug in if the car inverted at speed?

I guess we were all under too much constant competitive pressure and encouraging the design teams to come up with ever-faster machinery to think beyond just performance.

Too-early introduction of game-changing carbon fibre tubs in Indycar racing before this new material's properties were fully understood led to some leg-shattering crashes on ovals and speedways. Conversely, too-late adoption of composite chassis, especially perhaps in big sportscar racing, resulted in fatalities that could have been avoided.

I don't know what was in the minds of the engineers in one 1990s F1 team who almost certainly sanctioned the use of high-modulus carbon-fibre to make a composite monocoque that was very light and very stiff, but also very brittle, almost like glass. When the car crashed heavily it shattered catastrophically, on one occasion leaving the driver lying critically injured in the middle of the track, bizarrely and sickeningly attached only to his seat.

Even recently, the move to high noses for F1 cars and other formulae single-seaters has only just now been recognised as a driver hazard when a T-bone type impact is involved. This tweak should surely never have been permitted – it didn't take a genius to assess that particular risk!

Responsibility for driver safety does not lie just with designers. In the mega-boost turbo engine F1 era, fuels were used that were high in Toluene, very harmful to the human cardiovascular system and other additives that were carcinogenic. In the race to win, it seems that these dangers were ignored and swept under the carpet. Races were run sometimes in really extreme conditions of aquaplaning and spray that should never have been permitted, mainly because of the TV schedules – and the accompanying money that only got paid if the event went ahead.

Fortunately, due in major part to the tenacity of individuals such as Jackie Stewart, the late Sid Watkins and Max Mosley among others, a huge amount has been done and continues to be progressed in relation to driver safety. Even now, however, we have seen dangerous tyre failures in F1 aggravated by teams ignoring the manufacturer's clear stipulations as to their use.

LAT

Composites have increased car safety in recent years

At the Silverstone GP last year, the race director was criticised by some who should know better for stopping practice after the heavy rain caused aquaplaning crashes. But if the courage and talents of Alonso and others could not cope with the extreme conditions, was there any other responsible choice to be made? The new drivers trying to impress and retain their seats were certainly not the ones who were going to pull in.

The pressure to perform in motor racing now, especially with the amounts of money and anticipation and all the media and PR involvement, is hugely intense. Pressure can lead to decisions that in a less frenetic environment would not be countenanced. This is especially so for younger engineers and managers given great responsibility and aiming for the top, but lacking the maturity that only experience brings. Seeing first-hand the results of a near or fatal impact is very sobering – I can tell you that it stays in the mind when future decisions have to be made.

Certainly there is vastly more input from car and systems designers into the regulation-making bodies via the technical committees and working groups that now exist. Instead of being confrontational, this is positive cooperation which is to be welcomed. An indication of the value of this surely is the adoption of the new and could-be-hazardous KERS technology, which has been safely achieved.

Valuable work is carried out by organisations such as the FIA Institute, but the difficulty remains that they are generally only reactive, ie: they respond to a serious incident by investigation, consultation and the subsequent implementation of rules that should help prevent a similar occurrence in the future.

But maybe the FIA in particular, the ACO and similar key organisations such as IndyCar and NASCAR should appoint experienced and knowledgable engineers and motorsport professionals, supported with appropriate resources, whose sole function is to regularly meet and look ahead to try to identity dangers that are perhaps not immediately obvious – particularly when new technical and sporting regulations are introduced.

Nevertheless, nothing can replace the pause for consideration by the individual of the possible effects of a decision that go beyond the immediate seeking of greater performance. This, after all, is the meaning of responsibility.

Too-early introduction of carbon fibre tubs in IndyCar led to some leg-shattering crashes

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Top of the class

While many teams have treated the current F1 season as transitional, Red Bull have made the 2013 constructors' championship all their own

BY SAM COLLINS

"The recent regulation changes have been sufficiently small that we have been able to keep the DNA of the car throughout"

Between 2009 and 2013, it's fair to say that the cars of Red Bull Racing have dominated F1. The Adrian Newey-designed chassis have won all but one (2009) of the available titles, and that was largely down to the clever exploitation of a regulatory loophole by the Brawn team. Like most of Newey's designs over the years, the 2009-13 Red Bulls were gentle evolutions of each other with few major changes – but the details were constantly changing.

'We are four seasons on from 2009 and there have been lots of minor regulation changes along the way,' says Newey. 'But they have been sufficiently small that we have been able to keep the DNA of the car throughout. As always the issue is the law of diminishing returns - it really has been about detail development and trying to get every little bit out of all of the areas. If you sat an RB5 next to an RB9 there would be a clear and obvious resemblance. The knowledge gained from the development of the RB7 was fed into RB8 and from that the RB9.'

The gearbox is a typical example of this- the composite cased seven-speed sequential unit fitted to the RB9 is so

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The RB9 is fitted with the Renaultsport RS27, a normally aspirated 2.4-litre V8

The front brake ducts on the 2013 Red Bull. The car's braking system features Brembo calipers and carbon discs and pads

similar to that used on the RB8 that Newey was left scratching his head when questioned about the differences.

'Between RB8 and RB9 there is virtually nothing new about the transmission. The internals are as near as damn it identical too, although the casing is slightly different. The changes there are very small. Last year we introduced a very high wishbone with the driveshaft passing through the middle of it, which brought an aerodynamic benefit. That's been widely copied by others this season. That was quite a decent step last year, but it's the usual problem in F1 – everyone sees it and copies it.'

Indeed, Newey went on to reveal that the internals actually date back to the RB7 of 2011. They are also used by Caterham in its CT03.

All of the cars built by Red Bull from 2009 to date were fitted with the Renaultsport RS27 normally aspirated 2.4-litre V8, which has proven to be the most successful engine of the 2.4-litre era. The powertrain was little changed throughout the car's evolution, but one area where Red Bull was notably different to other teams was in their adoption of an energy recovery system. Newey highlights this as one of the main weaknesses of this family of cars.

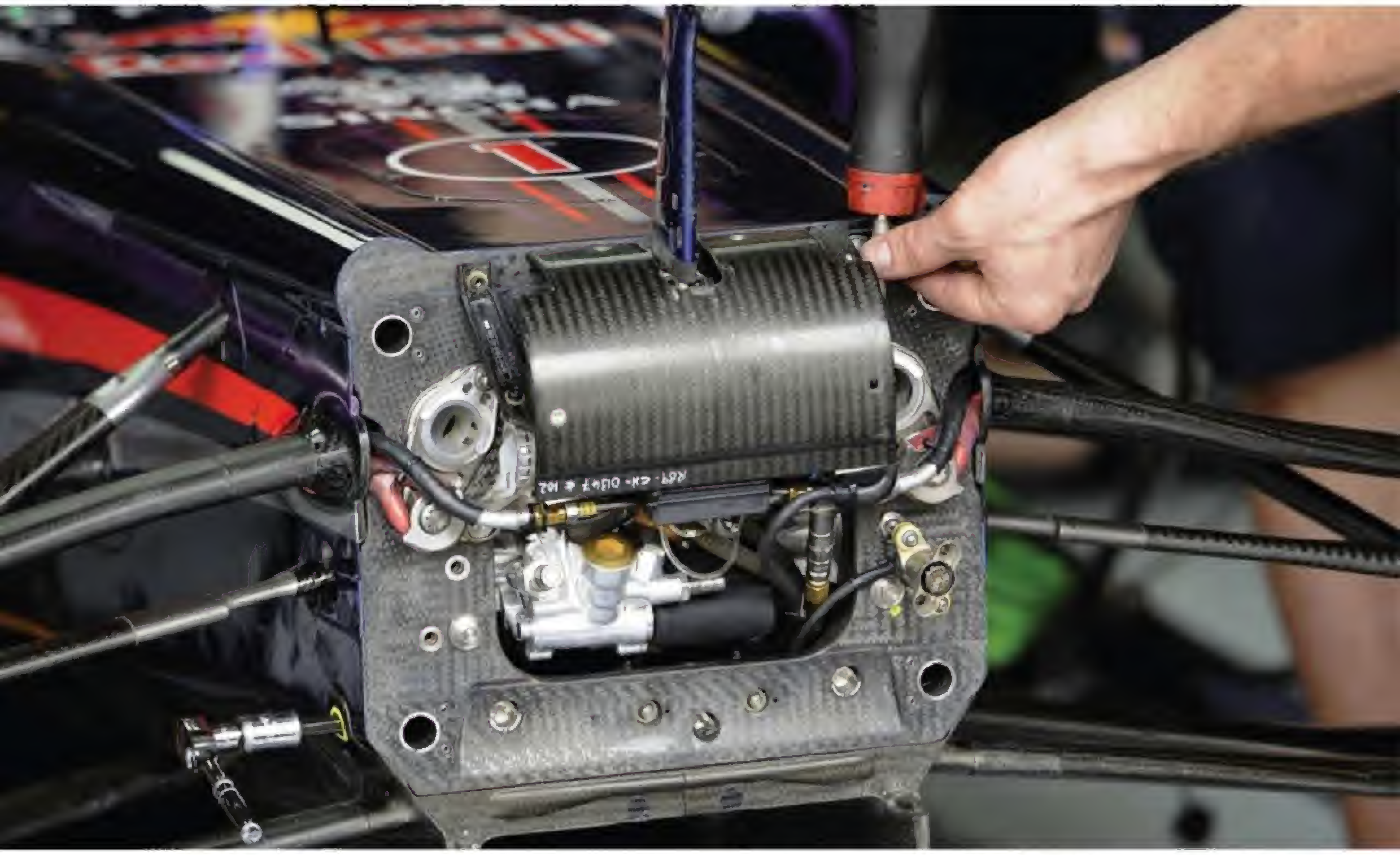
'In hindsight we missed a trick by not properly developing KERS in 2009,' he says. 'The potential was always there but in 2009 we were not mature enough as a team to take on that challenge. You could argue that between then and now we have gained 0.4 secs from KERS; the rest has been the usual aerodynamic developments.'

As with other cars in the Red Bull line, the RB9 has much of its KERS componentry mounted around the transmission, something that other chassis makers have avoided doing. The team's package is largely based on the Magneti Marelli system which first appeared in 2009, with some components similar or identical to those used by Ferrari. The unraced Peugeot 908 HYbrid4 LMP1 is also thought to share some components with this system.

'I think it's fair to say that we still struggle at high track temperatures,' says Newey. 'We package the batteries in and around the bellhousing, which brings with it weight distribution benefits in terms of the car overall, as we have shifted that mass rearwards. But thermally it is not where you would choose to put them, and it can bring some problems in very hot races.'

Red Bull was the first team to run a pull rod rear suspension under the current rules,

"Between RB8 and RB9 there is virtually nothing new about the transmission. The internals are as near as damn it identical too"



Adrian Newey claims that the RB9 retains its front torsion bars, which are more recessed on the bulkhead than on previous cars

something that every other major team has since copied. The layout remains on the RB9, although with many detail refinements, not least in that it is interlinked front to rear. Unlike some cars with such systems, Newey claims that the RB9 retains its front torsion bars, though they are not visible when the bulkhead is inspected: 'The torsion bars are still fitted, but are a bit more recessed in the bulkhead than on previous cars. We have had front to rear interlinked suspension on the car for quite a few years - it's a pitch connection which can give some benefits in ride.'

There is some speculation that the RB9 is also fitted with a system that links the suspension diagonally, but Newey would not be drawn on this.

Throughout the car there are many detail changes from the RB8 as Newey says, with one of the most notable lying at the front of the car. A minor rule change relating to the height of the nose at the start of the 2012 season saw all of the cars feature a rather ugly hump. Red Bull, uniquely, fitted a slot in the nose which it initially claimed was for driver cooling, but was later revealed to be used for cooling some internal components. It also seemed to have an aerodynamic function as it was linked to a second slot under the nose. A rule change would have allowed Red Bull to fit a non-structural panel in this area, but Newey and his team decided against that approach.

'We do have the vanity panel on there, but it does not stretch the whole way to the front of the nose as the weight of it would be too high for that,' says Newey. 'But we have dropped the letterbox vent which cooled the driver and some electronic systems.'

With the letterbox vent dropped on the RB9, the same solution found on both the 2012 and 2013 Saubers was employed, which featured a vent facing the driver. It is also linked to a slot under the nose.

McLaren's Matt Morris, who oversaw its introduction when he was technical director, explains that the concept is really very simple. 'Everybody is interested in it, but it is something that is

BLOWING THE NUTS

Early in the season the RB9 tested with an interesting wheel nut layout - there was a hole in the centre of the nut passing right though the hub. These became cheekily known as 'blown nuts' and were also trialled by the Williams team. At the time their purpose was not disclosed, though some speculated that they were for brake cooling.

'Last year we had a duct through the wheel which gave some small aerodynamic gains,' Adrian Newey explains. 'It was trying to do what we had when we had the wheel covers in the past. The way we did it last year was declared illegal during the season, I think at Montreal. The solution that ourselves and Williams then experimented with at the start of this year was much the same thing, but done in a way that was legal. Overall, however, we did not find a big benefit to doing it.'

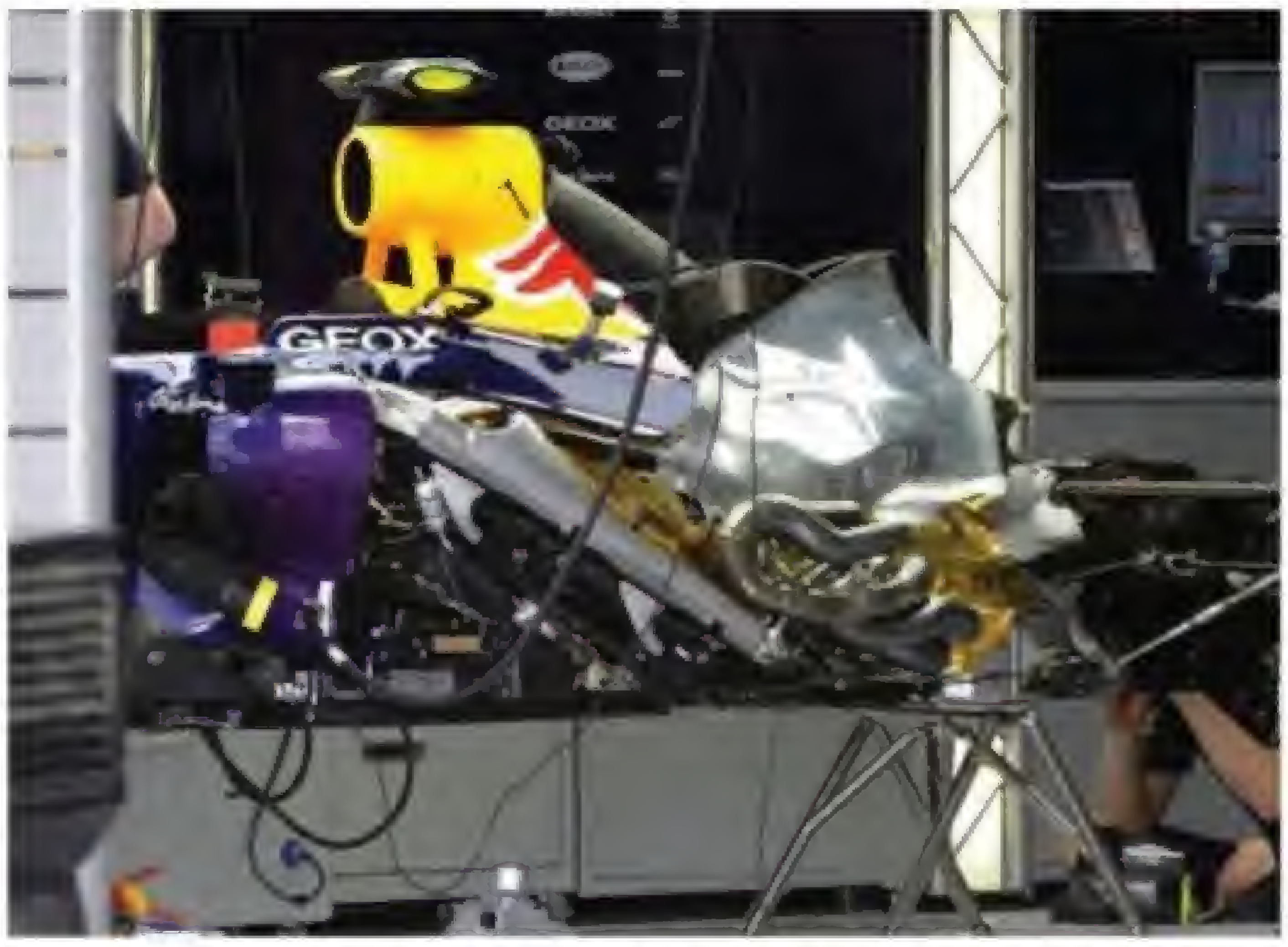
not actually worth much performance,' he says. 'When you look at the hump it is clearly not the best dynamic device on the planet, so we just use it to improve the flow in that area.'

One area where every team has struggled to a greater or lesser extent in the last two seasons is the tyres, and Red Bull is not an exception. With the original generation of Pirellis used at the start of the season, the RB9 was often not as strong as many expected that it would be, but after the spate of failures at Silverstone during the British Grand Prix, the Italian company was forced to essentially revert to its 2012 tyres.

Perhaps as a result of this, the RB9 seemed to make a significant step forward in pace. However, the mid-season tyre change also saw a practice used by a number of teams including Red Bull outlawed. Cars were regularly seen on track with the right rear tyre fitted to the left rear and vice versa.

'The 2013 tyre construction had ply steel built into it, which is a way of changing the toe without changing the toe,' says Newey. 'It's nothing especially magical - by swapping the tyre from side to side you are effectively changing the toe of the tyres.

'In reality the main benefit was wear management. In qualifying you take a lot out of the tyres - you are driving them as hard as you can and slip can be quite high. On the very heavy handed circuits you take a lot out of the left hand side of the car typically, so by swapping them for the race you get some benefit.'


WRI2

The Renaultsport RS27 has been the most successful engine of the 2.4-litre era, but Red Bull were relatively slow to capitalise on KERS gains

As the European season came to a close at Monza, Italy, the RB9 was - like its predecessors - dominant. With seven races still remaining, drivers from Mercedes, Ferrari and Lotus all admitted that they could not catch Sebastian Vettel in his RB9. Red Bull headed into the flyaway races with a seemingly unassailable lead in the constructors' championship. But with the resource restriction agreement in force, the engineers at Red Bull had to not only ensure that the RB9's development rate allowed it to keep its nose ahead, but also make sure that they did not fall behind on development of the RB10.

'We are having difficulty balancing the 2014 development with the 2013 car,' Newey admits. 'We are dealing with it as best we can. The people working on the long lead time parts like monocoque and gearbox are exclusively working on 2014 now. At the same time time, there is a small team of people working full-time on the 2013 car as we cannot afford to sit on our hands.'

'It's possible that there may be some small carry-over from RB9 to RB10, but with the size of the changes its not very much.'

The arrival of the RB10 early in 2014 will draw to a close one of the most successful lines of grand prix cars ever, but possibly the start of another equally strong lineage.

RB7 - THE WEAKEST OF THE BREED?

Of the five Red Bulls designed to the current rulebook by Adrian Newey and his team in Milton Keynes, one stands out to its creator as perhaps the weakest. 'The 2010 car (below) was the first year where we had designed it from the outset to have a double diffuser,' says Newey. 'We got a lot out of that concept and we were quite aggressive with the packaging of the car. It had a very long gearbox to maximise the area of the double diffuser. Performance-wise we have always had our nose ahead with this family of cars, and that's true of the 2010 car. But we struggled with a lot of reliability issues both on our side and also on the engine side. There were a lot of points thrown away as a result, and a few errors along the way to be honest.

'We made much harder work of the 2010 championships than we should have done. While we wrapped up the constructors' championship with a race to go, the driver's went right down to the wire. Indeed if the second Renault driver (Vitaly Petrov) had not managed to keep Fernando Alonso behind him, we would not have taken the title.' There is little doubt, however, as to which car Newey thinks was the strongest of the line in terms of relative performance.

'With hindsight it is clear to see that the 2011 championship was the easiest one. We had a car where we were able to always extract a bit more performance from, and that let us keep our nose ahead all season.'

LAT

TECH SPEC

Chassis
Composite monocoque structure, designed and built in-house, carrying the Renault RS27 2.4 litre V8 engine as fully stressed member

Transmission
Seven-speed gearbox, longitudinally mounted with hydraulic system for power shift and clutch operation. AP Racing clutch

Suspension
Front: aluminium alloy uprights, carbon-composite double wishbone with springs and anti-roll bar, Multimatic dampers
Rear: aluminium alloy uprights, carbon-composite double wishbone with springs and anti-roll bar, Multimatic dam
Brakes: Brembo calipers, carbon discs and pads

Electronics
MESL standard control unit

Fuel
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"We are having difficulty balancing the 2014 development with the 2013 car - we are dealing with it as best we can"

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Is Red Bull Racing using KERS to enhance mechanical traction?

Red Bull has dominated the F1 drivers' and constructors' championship since 2010. This is often put down to more efficient downforce generation, but David J Dodge believes that the car's advantage is down to a clever way to improve traction. He starts with a few facts and observations:

1. RBR cars are consistently the slowest of the top and mid-field teams in speed traps
2. RBR cars can consistently do the fastest lap times (they have most pole positions)
3. RBR has a higher average speed down long straights, despite having a ~10kph slower top end. They cannot be caught by faster cars
4. In order to have a higher average and lower top speed they must:
   a) have better traction out of the turns
   b) better traction into the turns
   c) better traction though the corners
   d) or all three
5. RBR's superiority is often attributed to the superior aerodynamic downforce Adrian Newey is able to engineer
6. If they had superior aero, they would have more downforce with the same drag and the same top speed or the same downforce with less drag and superior top speed. They don't
7. They are apparently able to take advantage of what appears to be high downforce/high drag setups, while other teams are not able to do so
8. Other teams are not stupid. If sacrificing top end speed for more downforce reduced lap times, they would all be doing it. Does RBR really have a higher downforce setup?
9. Superior aero does not seem to explain RBR dominance. Superior mechanical traction does
10. RBR has had consistent problems with their KERS
11. No other team has had KERS problems since the first year
12. RBR is very technically competent so why can't they solve a problem that everyone else has solved?
13. They must be doing something different with their KERS
14. They don't appear to be using KERS on the straights (low top end speed). They do appear to be using it at turn exits
15. The mysterious stuttering rubber marks on the exit of the Montreal hairpin may be a clue

In light of these facts and observations, what could RBR be doing that others are not, that gives them a consistent advantage? In other words, what would give them such an advantage and still be consistent with all the above?

The most important clue is their KERS problems. What could they be doing to make it so difficult in comparison to other teams? It must bring a significant advantage, or they wouldn't bother with the complexity.

So here we go! It is theoretically easy to modulate the output torque and charging input torque to an electric motor/generator using capacitors, batteries, inductors and a feedback signal. Torque changes are instant and control is easy. Here are a few things that RBR could be doing with a more sophisticated KERS:

1. If torque were to be modulated in response to the normal force of the tyres against the track (in response to shock pressure, for example) significant unused traction potential could be recovered during high pressure phases (upside of bumps) and initiation of full wheel spin during low pressure phases (downside of bumps) could be delayed. Yielding better turn exit acceleration, higher cornering speeds and stability. Especially on bumpy tracks
2. If torque were to be modulated so that the maximum traction is exceeded for only a very small rotation of the tyre and then relaxed to re-establish a new bond to the pavement, then pushed over the limit again, some additional thermal potential of the tyre could be taken advantage of and lateral grip would be more stable. This would yield better mid-turn grip, stability and speed
3. When the threshold of maximum traction is near, the modulation of torque and the consequent slip-catch would give the driver feedback on impending loss of grip. (Note: this may be a violation of the rules.) This could yield fewer driver mistakes and allow them to stay closer to the limit
4. Charging input torque could also be modulated to enhance rear wheel traction during braking. This could yield more effective rear braking, and delay the onset of rear wheel lock-up
5. This does not appear to violate any rules (except for No 3 above). It is traction enhancement, not traction control. Almost everything an F1 team normally and legally does is to enhance traction

Mark Webber's RB9 at the Nürburgring in July

LAT

ADRIAN NEWEY RESPONDS

Racecar highlighted the points raised here with Newey who seemed a little cagey about it all, though he hinted that while the RB5-RB9 line does indeed seem to have low end of straight speed, and relatively high mid-straight speed, this is not down to the usage of KERS.

'I doubt the gain is from KERS,' he says. 'We, like everyone, do work on how to best deploy it, but I think everyone is similar in how they use it. Is our traction better than others? I think it depends on the particular corner leading on to the straight.'

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The great power surge

As the long-awaited Formula E racer launches in Frankfurt, the start of a brand new era of motorsport might be upon us

BY SAM COLLINS

"I can say that this is without doubt the most difficult monocoque ever made by Dallara"

In 2014, the FIA hopes to radicaly change the face of motorsport forever, with the creation of its new all-electric open wheel racing series, Formula E. The championship is aimed at not only allowing manufacturers and suppliers to develop new electric powertrain technologies in motorsport, but it is also aimed at attracting a new audience to the sport. For this reason, all of the races will be held in urban environments.

The race meetings will all be run over the course of a single day, with practice and qualifying in the morning and the race in the afternoon or evening. There will be 20 teams, each with a pair of drivers, and each of those drivers will have a pair of cars. One car will be optimised for endurance, and the other for sheer speed (but the batteries will run down faster). Each race will last one hour, and at some point during the race the driver will have to make a pit stop to swap cars.

At the 2013 Frankfurt Motor Show, the first Formula E car to be built was revealed - the Spark-Renault SRT_01E. It has been built by new French company Spark Racing Technology, led by Frédéric Vasseur (see RCEV21 N11), together with a consortium of some major motorsport suppliers.

Despite its unconventional looks, much of the car is very conventional in mechanical terms - with double wishbone suspension with twin pushrod-actuated dampers front and rear. Braking comes via a fairly standard Alcon F1-style carbon/carbon setup. The powertrain, however, is very different as it is all-electric, which has understandably created a number of major design trade-offs.

'The electrical power unit does not have a significant effect on the design phase - the technology is already highly advanced,' says Antonio Montanari, Dallara lead engineer on Formula E. 'The power units are very small and light with respect to the amount of power that they generate.

'But batteries are another matter. A battery's energy density is so much lower than fossil fuels that it means we are still obliged to use large numbers of bulky, heavy power cells. This creates a whole range of design issues, especially the problem of weight distribution. In fact, in order to achieve the same performance and range as an IC engine, we have to install a motor and battery pack which weigh twice as much. That said, it should be noted that a few years ago it would not have been possible at all.'

COMPOSITE THINKING

From the outside, the Dallara chassis looks fairly conventional - however, it is anything but. One of the major challenges in the car's construction was down to the lack of a fuel cell. Where it would normally be mounted there is a void, meaning that where Dallara would normally support the roll-over structure, it has nothing, leading to some very innovative composites work.

'If you imagine a Formula 1 car, the battery box takes the place of the fuel tank and engine,' says Dallara's chief designer Luca Pignacca. 'It is a composite structure right through. The biggest challenge was the roll hoop. Because of the layout of the car, I can say that this is without doubt the most difficult monocoque ever made by Dallara. It would be easy to do the roll hoop test with the battery box on, but as we have seen over the years, cars can lose the engine in a big shunt. So, we insisted that the FIA roll hoop tests should be conducted without the battery box. It makes it much harder - you have to cope with the same roll hoop loads as a Formula 1 car without the structures that they have. There is nothing underneath it.

We had to use composites differently and use some materials that we would not usually use in something like a GP2 to create this cantilever chassis, and it does make this chassis a bit more expensive. As a result, the top part of the monocoque is a lot stronger than normal, and this raises the centre of gravity slightly.'

The tub has to meet very tough safety standards, as is expected in any FIA sanctioned series, and will have to undergo the usual crash tests.

'In terms of safety, the car meets F1 standards,' says Pignacca. 'The crash testing is basically the same normalised to the actual speed of the car and the weight of the car, so it is heavier and slower. It is not just about the chassis itself, but the battery and electrical safety - fire resistance, and things like that. It is a big challenge for a designer, a lot of new learning for us. It is interesting, because it is something totally new for us. We have done so many cars over the years, but this time it is a totally new exercise. Engineering-wise it is very fun.'

The battery box, which is bolted to the rear of the car, is a load-carrying structure and also supplied by Dallara. This was also

Much of the Spark-Renault's aerodynamic development was conducted in-house at Dallara

something of a challenge for the Italian engineers. 'It is a fully stressed member,' says Pignacca. 'It has to be very strong to pass the crash tests, it makes sense to make it structural as a result. It's like having a big strong engine block. To change the box would take almost the same amount of time as it would take to change an F1 engine. The difference is that when you work on an F1 engine after a session it is hot. This is cold, but the battery can still be live. People will have to learn how to handle this technology – officials, teams, drivers and spectators. There is a lot of learning to be done.'

While Dallara has designed and built the battery box, Williams Advanced Engineering (WAE) is supplying the batteries. 'The battery in the car is substantially larger than you find in KERS,' says Paul Newsome, WAE chief technical officer, 'but the Jaguar C-X75 project moved us into large batteries, and that learning can be found here. We have taken elements from F1 KERS for performance and others from production cars for longevity.

'The chemistry is very similar to the Kokam cells used in F1, but not the same. However, it is much closer to that, than what you would find in a road car.'

The battery management system is also supplied by Williams. The firm would not be drawn on the the precise details of the battery pack, but a source inside Formula E revealed that the pack would capable of producing 200kW, the equivalent of 270bhp.

Driver instrumentation on the new car is substantially modified from that found in Formula 1 cars, although it essentially runs on the same software

While Williams provides the batteries, the actual drivetrain of the car has been created by McLaren, with more than a nod to its new P1 hybrid supercar.

'When Formula E was conceived, it was around the same time that the first production parts of our electric motor were appearing,' says Peter van Manen, of McLaren Electronics. 'The motor in the car is essentially the same as in the P1, with some evolution for running fully electric. We are not known for motors, but four years ago we developed an electric motor and associated controls for the McLaren P1 road car. The reason we did that was very simple – we were creating a hybrid. We needed a very high performance electric motor for that and we could not find one on the market, so we decided to do it ourselves.

'We were convinced by the Formula E guys to give them a bit more torque and power, as racing cars do not have to run on the road for many years, so we could afford to turn the wick up a little bit.'

McLaren Electonics also supply the chassis electronics, with the control unit used on the Spark-Renault identical to that found on the Dallara DW12 Indycar. 'The software is different, however, as we do not need things like direct injection,' says Van Manen. 'The driver instrumentation is different to that used in F1, but they are the same software.'

"The most important thing for these cars is keeping the drag down – for this reason the rear end is quite similar to the DW12 IndyCar"

Unusually for an electric car, the Spark features a conventional gearbox supplied by Hewland. 'We chose to use a four-speed transmission,' adds Van Manen. 'It is a normal sequential box. I think that using a gearbox adds to the racing and it allows us to deal with the speed ranges we would like to see.

'It lets us get the most efficiency out of the motor. It is a bespoke box, but it is an evolution. Wherever we can with this project, we have tried to find high performance starting points that just require a little evolution.' To keep costs under control, the ratios in the box are fixed.

Finally, the look of the car was a key concern for the organisers and aesthetics were as important as aerodynamics in the cars development. The series organisers were keen that Formula E did not look like a slow and silent derivative of Formula 1.

'It is a combination of styling and aerodynamics. The car had to be new and look different, and it had to be something people would like,' says Pignacca. 'So we had to trade off aerodynamic efficiency and styling. The downforce is not huge. With this sort of racing and the tight low speed circuits that this car will race on, it is not important. We still have decent wings and a decent diffuser and the aero performance is similar to an F3 car in low-to-medium downforce trim.

'The most important thing for these cars is keeping the drag down. For example, the design of the rear end is quite similar to the DW12 IndyCar because we are trying to reduce the drag on the rear wheels in the same way. We also use front wheel covers for the same reason.'

Most of the aerodynamic development was conducted using Dallara's in-house CFD capability, but the engineers from Spark intend to validate the design in the full-scale wind tunnel at St Cyr in France.

There is a cost cap on all of the elements of the car, as according to series officials it is meant to be an affordable racing series, but that raises the question of costs. Each car will cost no more than €350,000, and each team will require four cars. However this price is not

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"This will cost a team no more than GP2 does - every team will be able to make a profit"

something teams will have to bear, according to Alejandro Agag, CEO of Formula E Holdings. 'The teams do not pay for the cars. We supply them, but the teams pay for the spare parts and insurance. We know what the real budgets are, and this will cost a team no more than GP2. Every team will be able to make a profit.'

With the majority of funding in teams across motorsport coming from either drivers or car manufacturers, Formula E looks rather exposed as both of those avenues seem largely closed off, leaving only the precarious world of corporate sponsorship available as a funding source. However, Agag does not feel that the series will struggle in this respect.

'I do not think it is difficult to attract corporate sponsorship to this. One of the things I have noticed is that this championship seems to reach a totally different group of people and companies than conventional racing. These companies have a sustainability message to pass on, so the people paying attention are a completely different group.

'The key is to keep the budget low for the teams. To find a €10-15m sponsor is difficult whoever you are, even in F1, but to find a €1m sponsor with the level of TV coverage we have is much easier, so the teams only need two or three of those.'

Another area that many see as a stumbling block to the series really taking off is its insistence on only using urban circuits, something that is widely believed to be fearsomely expensive. For an electric racing series it creates another major issue, the demand on the energy grid of charging 40 battery packs at once in one location. Agag again does not see this as an issue.

'The street circuits are expensive, but there is a mythology about how expensive they truly are. Don't look at Formula 1's circuits - instead you should look at IndyCar venues. They make street circuits for good budgets. The circuits will be sanctioned to Grade 3 as well - not Grade 1 - which will keep the costs down.

'Charging the batteries during the day won't be a big problem anyway in terms of grid demand. Our demand is about 1.5MW, while a football match needs about 6MW. So if our pits are next to a stadium, it's easy. In future we are looking at being fully autonomous, using hydrogen fuel cells in the pits to generate the electricity.'

In the second season of Formula E, the Spark-Renault will be joined by other designs as the series becomes fully open, Drayson racing has already announced that it will fit its own powertrain to the Spark chassis, while the Bluebird group aim to supply a full car.

The hope of all involved is that by the third season, the series will be a major global sporting event. Whether it will succeed, only time will tell.

TYRE SUPPLIER

Michelin has been appointed the sole tyre supplier for the first two seasons of Formula E. It aims to use the series to develop its knowledge of electric vehicles and to feed that data directly into production car tyres. 'The theory of the championship is racing towards the future, so when we thought about the tyres we had to thing about innovation and the future,' says Serge Grisin, director of Michelin's four-wheel motorsport programmes.

'Its an 18-inch low profile tyre - the first time such a tyre has been used on an open wheel car. It's more efficient; it is treaded so that we can run in both wet and dry conditions. It's an innovation and a big technical challenge, as in the dry we will have much better performance than a normal wet tyre, and in the wet we will have good performance too. We need to have not only a good compound, but also the tread pattern. It has to work in so many different conditions, from Malaysia to London.

The different surfaces are a challenge, because they are city streets and parks, with asphalt, concrete, white lines - and even tram tracks.

For us what is really interesting, is that the nature of the circuits and the tyre mean that the lessons we learn here can quickly be adapted to the production car products.

It is a new way of thinking for us with motor racing tyres. It has lots of knowledge from rallying rather than racing, but also from Le Mans with our hybrid slick used in LMP1.

What we want is the best conditions to learn from the track to the street. Competition has the important role of being the laboratory for the future of street tyres, so we want to be close to street tyres to learn.'

TECH SPEC

Spark-Renault SRT_01E

Design
Aerodynamics optimised to facilitate overtaking
High ride height sensitivity and wide range of suspension setups
Compliant to FIA safety regulations

Technology
Compromise between performance and cost-effectiveness wherever possible
Extensive use of composite materials but limited usage of the most expensive carbon fibres

Dimensions
Overall length: 5000mm (max)
Overall width: 1800mm (max)
Overall height: 1250mm (max)
Track width: 1300mm (min)
Ride height: 75mm (max)
Overall weight (inc driver): 800kg (min); batteries on their own 200kg

Power
Max power (limited): 200kw, equivalent to 270bhp
Race mode (power-saving): 133kw, equivalent to 180bhp
'Push-to-Pass': 67kw
Maximum power will be available during practice and qualifying sessions. During races, power-saving mode will apply with the 'Push-to-Pass' system temporarily allowing maximum power for a limited time

Performance (estimated)
Acceleration: 0-100km/h (0-62mph) in 3s
Maximum speed: 225km/h

Engine
MGU: McLaren
Maximum of two MGUs allowed, linked only to the rear axle
No traction control
Traction battery: Rechargeable Energy Storage System (RESS)
Maximum weight of the battery cells and/or capacitor -200kg

Chassis
Chassis/survival cell: Dallara carbon/aluminium honeycomb structure
Front and rear wing - carbon structures and aero styling
Bodywork: carbon - kevlar honeycomb structures

Gearbox
Hewland paddle shift sequential box
Fixed gear ratios to reduce costs

Brakes
Alcon bespoke carbon F1 spec

Wheels & tyres
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Ben Bowlby and the Nissan ZEOD

With his latest project, the British-born engineer has landed his second Garage 56 slot in three years. And here's why...

BY PETER WRIGHT

If there is a visionary engineer in motorsport today, it is surely Ben Bowlby who qualifies for the title. Having conceived the DeltaWing as a sustainable, 300cv solution for IRL, been rejected in favour of sticking with the 600cv dinosaurs of the ovals, he successfully wooed the ACO to consider the car in two-seater form for their forward-thinking Garage 56 slot in the 2012 Le Mans. The boldness of the concept not only attracted key partners Nissan and Michelin, but also caught the imagination of young people - potential fans that are missing from so much of motorsport. Why? The car was 'cool' and ticked many of the sustainability boxes that matter to this generation.

The DeltaWing went on to deliver most of what it promised and proved that current racing car design is twice as heavy, twice as powerful and twice as consuming of fuel and emitting of CO_2 as it needs to be. Nissan, like the rest of the automotive industry, is right in the middle of trying to establish what configuration of cars consumers are going to buy in the future. You can talk about technology, create show cars and prototypes, customer-test limited numbers of new concepts, but until you offer consumers production versions with actual performance, actual range and actual costs, you don't find out if you are right or wrong.

Nissan is at the forefront of EVs, with its pioneering Leaf. However, as with other similar EVs, it is not achieving sales targets as consumers are put off by cost and range limitation. The whole EV experiment is beginning to confirm that these vehicles have a real application in cities and in commuting from the suburbs, but really only for people who either use a car for nothing else, or are well-off enough to afford other vehicles for long distance and family motoring. The potential best compromise is the plug-in hybrid: battery power for city use, and efficient IC engine for intercity and rural journeys. Motorsport is a great demonstrator of the status of new and emerging technologies, and it is for this that Nissan has taken Bowlby's efficient racing vehicle technologies and is wedding them to their hybrid technology in the Nissan ZEOD for Garage 56 at the 2014 Le Mans race.

Bowlby is a racing car engineer who relishes conceiving and designing cars unconstrained by regulations

EV racing cars have already demonstrated performance at the Nürburgring Nordschleife (Toyota), and Pikes Peak (Nobuhiro 'Monster' Tajima), as well as showing their outright speed potential (Drayson Lola), but they run out of puff after around 15-20km at racing speeds, and none of the venues have anything like the cachet of Le Mans. Achieving a lap of Le Mans at racing speed on battery/electric power alone is obviously feasible, but would be all over in under four minutes, leaving 23 hours and 56 minutes during which the achievement might be forgotten. Racing for the full 24-hours, with one lap in each 12 lap stint in ZE mode under electric power alone, and the other 11 laps in series-hybrid mode, using a tiny efficient IC engine, is feasible. This cycle would emulate a potential cycle for such a hybrid road car and would be noticed - and that is what the ZEOD hopes to achieve.

Bowlby is a racing car engineer who relishes conceiving and designing cars unconstrained by regulations, a situation that is rare outside land speed record attempts, and leads to frustration in many in F1 design today. In the ACO's Garage 56, he has found the freedom to exploit his vision - although the ACO does impose certain some constraints - and it is a partnership unique in motorsport. The car must of course meet the highest LMP1 and FIA standards of safety and - crucially - must not be faster than the Audis, Porsches, or Toyotas. One further condition the ACO has imposed on Nissan is that, to justify their second occupancy of Garage 56 in three years, the ZEOD must be a step to a full Nissan LMP1 challenge at Le Mans and in the WEC.

The performance the ZEOD is targeting is:

- **In ZE, pure EV mode - faster than the GTs**
- **In hybrid IC engine mode - LMP2 performance**

It is planned that the first 11 laps of the stint will be in the latter mode and then, with the fuel tank empty and battery fully charged, it will do one lap as an EV. The fact that this last lap of a stint will end up in the pits means that it will not be timed as a flying lap, but no doubt Nissan will arrange for a flying ZE lap for the record.

Bowlby is contracted as a consultant to Nismo - Nissan's motorsports division. Nismo have contracted Ray Mallock's RML Group to design and build the car, while Nissan provides the full hybrid powertrain, IC engine, electric motors, batteries and all the associated controllers, and Michelin returning as the chosen tyre partner. RML then sub-contracted Ben to carry out the aerodynamic design over an intense three month period, and he supplied full body design and cooling data to RML. The aerodynamics are all-new, and the closed car is significantly different from the open DeltaWing. All downforce is generated by the underbody and Bowlby has taken great care once again with

The ZEOD weighs 700kg with driver and 50 litres of fuel, considerably heavier than the DeltaWing

the aerodynamic stability of the car. Further developing his unique technique – as applied to the DeltaWing – of testing the stability of an 1/18th scale model (for equivalent Reynolds number in water) by dropping it down the side of a swimming pool both forwards, sideways, and backwards. He found a pool with concave walls and the model stuck to the wall under all conditions. These results, combined with FIA LMP1 standard crash tests adapted for the lower weight of the car, met the second item of Nissan's brief to the RML designers:

Design and build it:
- **Fast enough**
- **Safe enough**
- **Reliable enough to finish the Le Mans 24-hour race**

Without the constraint of regulation, there might be a temptation to include all sorts of trick stuff on the car. However, it is novel enough in so many areas that the rest is really pretty conventional, giving it the best chance of achieving the third item on his list in the limited development time available.

The first item – faster – is a bit more complex and considerably more difficult. To accomplish its demonstration of ZEOD [Zero Emissions on Demand], it starts with a disadvantage. In ZE mode, it has to carry around, unused, the IC engine and all its ancillaries and cooling system, and including the fuel tank, albeit empty for the demonstration lap. In hybrid mode it has the burden of the excess batteries over and above the energy storage needs of KERS operation.

Let's look at the ZE mode first, as this sizes the batteries and motors. The ZEOD is fitted with two, 110kW continuously-rated motors giving 295cv in total, mounted alongside the five-speed transmission and driving the input shaft of the gearbox. The transmission is there by necessity for the IC engine. What is gained is that the motors can work within a narrow, optimised RPM range and as a result the batteries can be smaller and lighter. What is lost is the ability to drive each rear wheel individually, providing differential action and – subject to agreement with the ACO – torque vectoring. The batteries are the same chemistry as the Nissan Leaf's cells, and provide 12kWh (43MJ) of usable energy storage, weighing in at 120kg.

There is no way the ZEOD – which tips the scales at 700kg with driver and 50 litres of fuel, with just under 300cv, equivalent to 2.4kg/cv – could ever be as light as the DeltaWing's 570kg in the same condition. With just about the same electric power as the four-cylinder Nissan engine in the latter car (1.9kg/cv), the ZEOD must be slower under electric power alone. On top of that, the extra weight requires more downforce, and hence inevitably more drag. Put in more electric power to compensate and the battery weight goes up: a vicious upward spiral. Reversing the direction of the spiral, which is the Ben Bowlby

As with the DeltaWing, Bowlby tested the ZEOD's stability by dropping a scale model down the side of a swimming pool with concave walls

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Ray Mallock's RML Group have been contracted to build the car

In top gear, the Nissan ZEOD will operate between 6000-7200rpm

doctrine, and reducing size, weight, downforce, drag, power, and energy storage is limited by the need to accommodate a driver plus the space for a passenger, and to provide safety protection for the former.

It is worth noting here that SuperKarts, with their 60-90cv and 200kg are just as fast around a circuit as a Radical SR3, with 220cv and 650kg, so this philosophy does work right on down to very low mass if you can race such a vehicle to the appropriate regulations.

The ZE range is one lap of Le Mans, the other 11 laps of a stint being in hybrid mode. Power for this will come from a specially designed Nissan, three-cylinder, 1.5-litre, turbo GDI engine, producing 260kW (350cv). It will not be a true series-hybrid, with the engine running at constant speed to generate electrical energy stored in the batteries because that transmission path is just too inefficient. Like the Chevrolet Volt, the engine will transmit power directly and mechanically to the rear axle as well as driving the generators. While the Volt only does this in top gear, the ZEOD will use a five-speed conventional gearbox allowing the engine to operate between 6000-7200rpm. As mentioned earlier, the motor/generators and battery also benefit from this arrangement.

This motorcycle-sized IC engine is AV-mounted behind the rearmost part of the monocoque, which forms the 50-litre fuel tank and also houses the batteries, accessible from beneath the car. AV mounting gives all the electronic accessories and other delicate parts the best possible reliability environment. Cooling of the various systems is split into two, with a radiator behind each rear wheel fed by a small pitot intake above the wheel, and exhausting into the base region behind the car for excellent aerodynamic efficiency.

One circuit cools the IC engine and motor/generators using glycol; the other cools the turbocharger's intercooler and the batteries with a dielectric fluid. When the IC engine is working hard, the motor/generators are not on a continuous duty cycle, so can share their cooling system. When the batteries are working hard in the ZE mode, the turbocharged intake air is not needed and so these two can also share a cooling system. Neat!

There is no requirement to run a fuel flow-metering device, as Garage 56 does not have a fuel flow limit. Nissan may run one of the LMP devices to gain experience of it for future application in their LMP1 car. Nissan's objectives for the ZEOD are no walk in the park. To be able to race competitively at Le Mans for 11 laps then complete a 12th lap – albeit at slightly reduced speed – in ZE mode is quite a challenge. Nissan want to demonstrate the status of their technology for a road car cycle of, by way of example, driving from Birmingham to the M25 around London at high speeds on the motorway, switching to ZE, all-electric mode within the M25, then filling up the fuel tank and driving back to Birmingham. This is very likely to become one of the definitive road car cycles for which manufacturers develop mainstream cars.

AV mounting gives all the electronic accessories and other delicate parts the best possible reliability environment

Simulation shows that Ben's ZEOD car with Nissan's powertrain technology can achieve this. First tests are about to start as this is written, and then there are nine months to refine and optimise the car for the 2014 Le Mans.

Bowlby's proven philosophy of reducing the scale of everything to achieve efficiency – although not yet widely adopted in motorsport due to entrenched interests – is fascinating to play the numbers with. If one takes is a ZEOD, plug-in and fully charge the batteries in the garage, put – say – 15 litres of fuel in the tank, one would end up after a warm-up lap on the IC engine alone with a 670kg car and a potential 650cv. That's 1kg/cv, for one lap...

'Merde! Hé, Monsieur Bowlby, tiens, tiens! Merde!'


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DeltaWing hits ALMS

The next generation of the Garage 56 favourite takes to the track

BY MARSHALL PRUETT

The long-anticipated DeltaWing Coupe made its debut at Circuit of The Americas in late September, fulfilling the marque's most ambitious goal to date since American Le Mans Series founder Don Panoz assumed control of the company in 2012.

Dubbed the DWC13, the Simon Marshall-designed, Élan Technologies-built monocoque replaces the original DeltaWing concept, dubbed the 'Roadster' by Panoz, which made history as the first Garage 56 entry at the 2012 24 Hours of Le Mans.

Ben Bowlby's creation, which used an Aston Martin AMR-One LMP1 tub with a bolt-on front substructure that carried the front suspension, steering and crash structure, and a Ray Mallock Limited-developed Nissan 1.6-litre turbocharged four-cylinder engine, returned under Panoz's control in 2013 with a new Mazda-based engine from his Élan Power Products concern and new tyres from Bridgestone, but the rest of the car was essentially unchanged from its original form.

Owing to his long history of leaning towards innovative (or decidedly unique) solutions, Panoz, together with Marshall, embarked upon replacing the AMR tub with a bespoke, ACO-compliant coupe shell to further distinguish the marque's place within the prototype ranks.

Following the now-common practice of manufacturing a single-piece shell, the DWC13 is sufficiently stiff, but according to DeltaWing Racing team manager Dave Price, the car's small-tyre, narrow-track front layout allowed Marshall to save weight during the manufacturing process.

'This isn't the normal situation where monocoque stiffness is the goal,' he says. 'The previous tub was more than stiff - it was stiffer than we needed. Because of the car's design, there really isn't anything like the torsional loads a conventional racing car will generate. There simply isn't that twisting going on with the DeltaWing, so part of the design concept was to avoid going down that path.

"We have to think in a very different way to fit the needs of a car that is completely unlike anything else that's out there"

The Coupe has a Mazda-based engine from Élan Power Products, a change from the original's Nissan 1.6-litre

'And by doing so, that allowed us to eliminate a good amount of weight – to remove certain panels – and to go about the construction without going heavy in the ways one normally would when designing a chassis to be as stiff as possible. It really requires us to think in a very different way to fit the needs of a car that is completely unlike anything else that's out there.'

Without sidepods on either side of the driver compartment, the choice was made to affix the seat and driver controls in the centre of the DWC13 – a notable change from the other prototypes it will compete against in the United SportsCar Championship in 2014. Although the car is outside the ACO rulebook in that area, Price says it isn't a permanent solution.

'Our car can comply very readily with the 2014 regulations,' he explained. 'It's got all the side impact structures there. It complies with everything else. If there's any need for us to move it to one side, it's no more than a couple of hours work. Simon's taken all of that into consideration when he was designing it. His thinking in putting the driver in the middle – from a safety point of view – is that we don't have a lot of bodywork around the side to absorb energy like a conventional LMP car does. So his view was to put the driver in the middle to make them even safer.'

Seat and controls are affixed in the centre of the DWC13 – which is a marked change from the prototypes it will race against

In addition to the pronounced coupe shape surrounding the cockpit – another visible change from the AMR-One tub – is the lower chassis section and longer channel that runs between the front wheels, effectively lowering the car's frontal area. Marshall has also added an overhead air intake to feed the 1.9-litre, direct-injected engine's intercooler.

With its Nissan engine, and again with the Mazda derivative, the DeltaWing carried its oil and water radiators in its sidepods along with the intercooler. Having so many cores demanding air in such a small space led to cooling issues that dogged the Roadster in 2013, but with the move to the Coupe, Marshall sought to alleviate the temperature issues by taking a page from the Porsche 962 days by moving the intercooler above the engine. Thanks to having more space available in the sidepods to cool the engine's fluids – as well as the effective use of the overhead intake to flow air through the engine bay and out through massive louvres mounted to both sides of the engine cover – the Coupe ran cool despite temperatures closing in on 100degF at COTA.

"When you explain the DeltaWing to people and tell them where we are and what we're doing – they listen"

Marshall also opted to redesign the entire turbocharger system, moving the unit to the rear of the car where it now rests above the gearbox and suspension.

The Coupe was built in only two-and-a-half weeks due to another smart decision made by the DeltaWing team.

'Basically, the mechanicals, the suspension and the gearbox – it's all the same as the Roadster,' says Price. 'So we didn't expect too many problems there. We try not to change too much on it.'

'The difference in the Coupe and the Roadster – apart from the roof – is the centre of the

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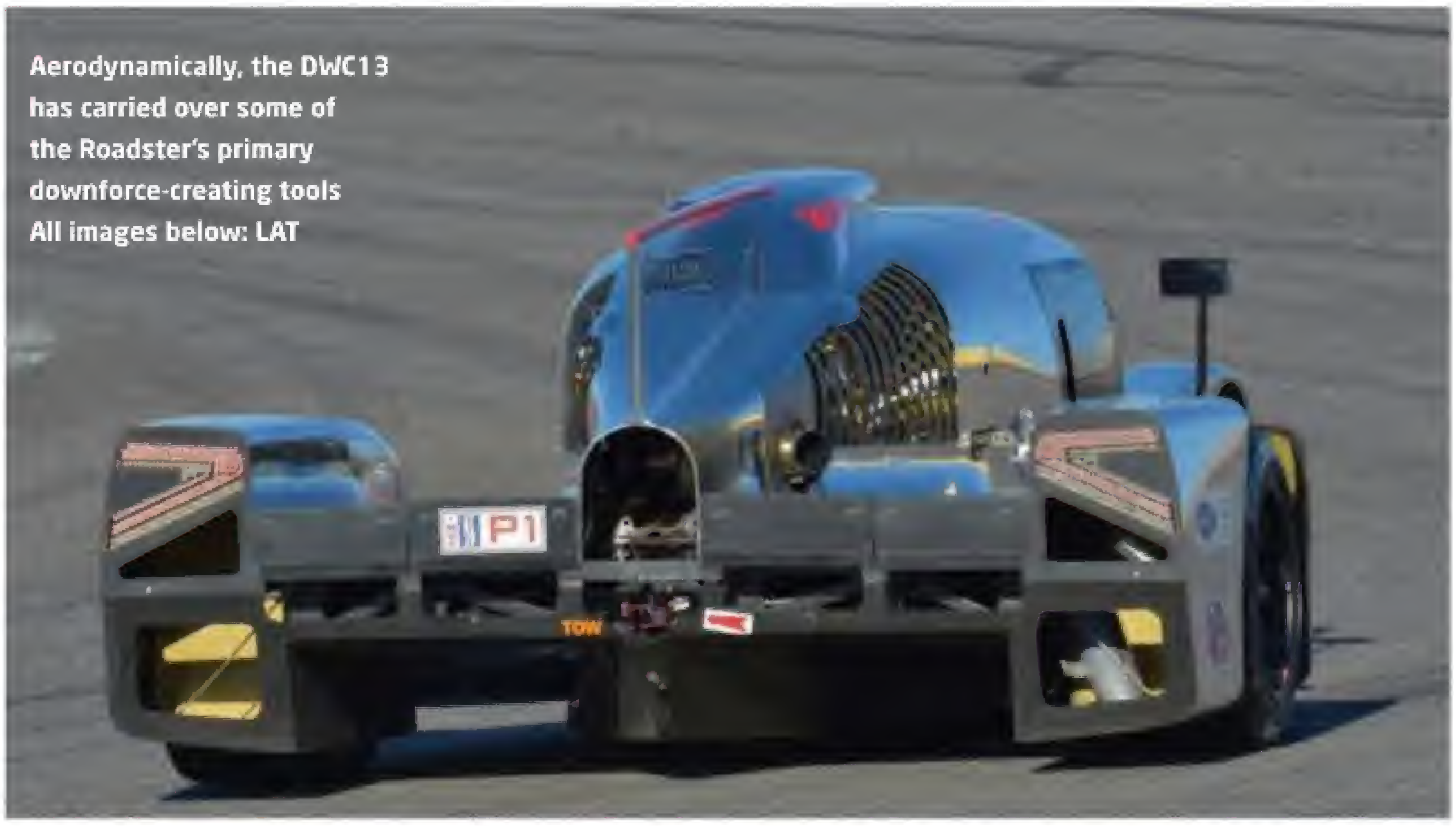

Aerodynamically, the DWC13 has carried over some of the Roadster's primary downforce-creating tools All images below: LAT

nose. It's a lot lower between the wheels, so we've lowered the frontal area.'

Other than slight modifications to the mounting position of the rear frame that carries the DWC13's original DeltaWing suspension components, the Coupe has been close to a direct bolt-on replacement for the AMR-One tub.

Aerodynamically, and with the obvious closed-top considerations in mind, the DWC13 has also carried over some of the Roadster's primary downforce-making tools, like the All American Racers BLAT (Boundary Layer Adhesion Theory) pieces that feed the car's tunnels. Tall rear Gurneys are also used to aid in extracting air from beneath the car, but Price says the Coupe will take another step forward in its aerodynamics before the end of the year.

'Most of the changes have been aimed at trying to improve the aero a bit. We've still got another development to go on that with the underbody,' he says. 'We deliberately made modifications to the chassis, so that we've got some ability to improve the underbody further.'

Three Coupe tubs have been manufactured, and with Panoz's stated goal of selling all three, Price believes the DWC13 can be seen as a viable P2 option once potential customers begin to view it as a serious racing car.

'We need to establish where we are with this car in races that remain in this year,' he says.

Development of the new DeltaWing's underbody continues, with the team acknowledging there are still aero improvements to be made

Three Coupe tubs have been manufactured to date, with the hope being that customers start to view it as a viable P2 option

'I've spoken with several people about their plans, and most of them – when I suggest that they consider buying a DeltaWing – look at me as if I've gone completely barmy.

'The difficulty is with people overcoming their prejudices against it because it's different. And I think that's what a lot of people will think – "I'll go for the safe option". Don, in the usual fashion, didn't go for the safe option and he's proved it to be a very viable car.

'And now when you explain it to people and say where we are and what we're doing, all of a sudden they listen to you. We've got everything here to support customers and if you look at its first race, it was right where you'd expect a new car to be.'

The new DeltaWing qualified third overall at COTA. 'It still needs to overcome scepticism,' Price concludes, 'but if everything goes well, we hope to have a few Coupes to contend with next year.'

TECH SPEC

DeltaWing Coupe DWC13 2013

Engine
Type: 4 cylinder 1.9-litre Élan Power (direct injection gasoline turbo)
Maximum power output: 350bhp at 6800rpm
Maximum torque output: 270lb ft constant from 3500-6800rpm
Throttle type: drive-by-wire
Water pump: electrically powered
Cylinder block weight: 25lb
Engine weight: 176lb
Fuel type: E85 VP
Exhaust system: 4 into 1 exhaust with external waste-gate

Transmission
Gearbox: five-speed sequential
Clutch: two plate – carbon-carbon
Shift system: pneumatic paddle shift
Drive shafts: equal length tripod-jointed half shafts

Chassis
Type: FIA homologated carbon fibre monocoupe
Front suspension: double-wishbone, unequal length, with coil over shock units to lower wishbones
Rear suspension: double-wishbone, unequal length, with pushrod/rocker actuation of coil over shock units

Steering: Bevel quadrant steering box without power assist
Dampers: Coil over hydraulic dampers
Anti-roll bars: torsion bar (rear). No front anti-roll bar
Fuel tank: FIA-spec gasoline fuel cell
Brakes: vented PFC carbon/carbon discs with 4-pot aluminium monoblock calipers
Wheels: forged magnesium one-piece
Front wheel size: 15-inch diameter, 4-inch wide
Rear wheel size: 15-inch diameter, 12.5-inch wide
Tyres: Bridgestone
Front: 4.0/23/R15
Rear: 12.0/24.5/R15

Dimensions
Weight: 490kg without fuel or driver, 590kg with fuel and driver
Weight distribution: (front/rear) 28/72
Overall length: 4.65m
Front width: 0.76m
Rear width: 2.08m
Height: 1.03m
Wheelbase: 3.05m
Track width (front) 0.6m
Track width (rear) 1.74m

Bodywork
Tub and body: carbon composite
Aerodynamics: twin vortex underbody downforce system – BLAT (Boundary Layer Adhesion Technology)

Performance:
Top speed: 195mph
0-60mph: 3.3s

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Pace setter

Bloodhound is still three years away from a record attempt, but development of its innovative technology is well under way

BY PHILIP WELTRAUM

The race to 1000mph is on, and while the British Bloodhound SSC team may be three years from being ready, already it is setting milestones. The car will complete low speed runs in the second quarter of 2015 in the UK, before heading out to South Africa to attempt 800mph later in the year, a speed that would already increase the existing record. The plan is for the team to then go for 1000mph in 2016.

While the American Eagle team harbours plans to go for the land speed record early in 2014, Bloodhound has just started to build its car using Formula 1 and aerospace technology.

FUTURE TECHNOLOGY

The Bloodhound programme is making the most of its opportunity to work without a rulebook to develop materials for such things as the race suit, boots and gloves that will be worn by driver Andy Green, as well as applying knowledge of 3D printing to create complex lightweight structures that could be used to replace carbon composites in helmet design.

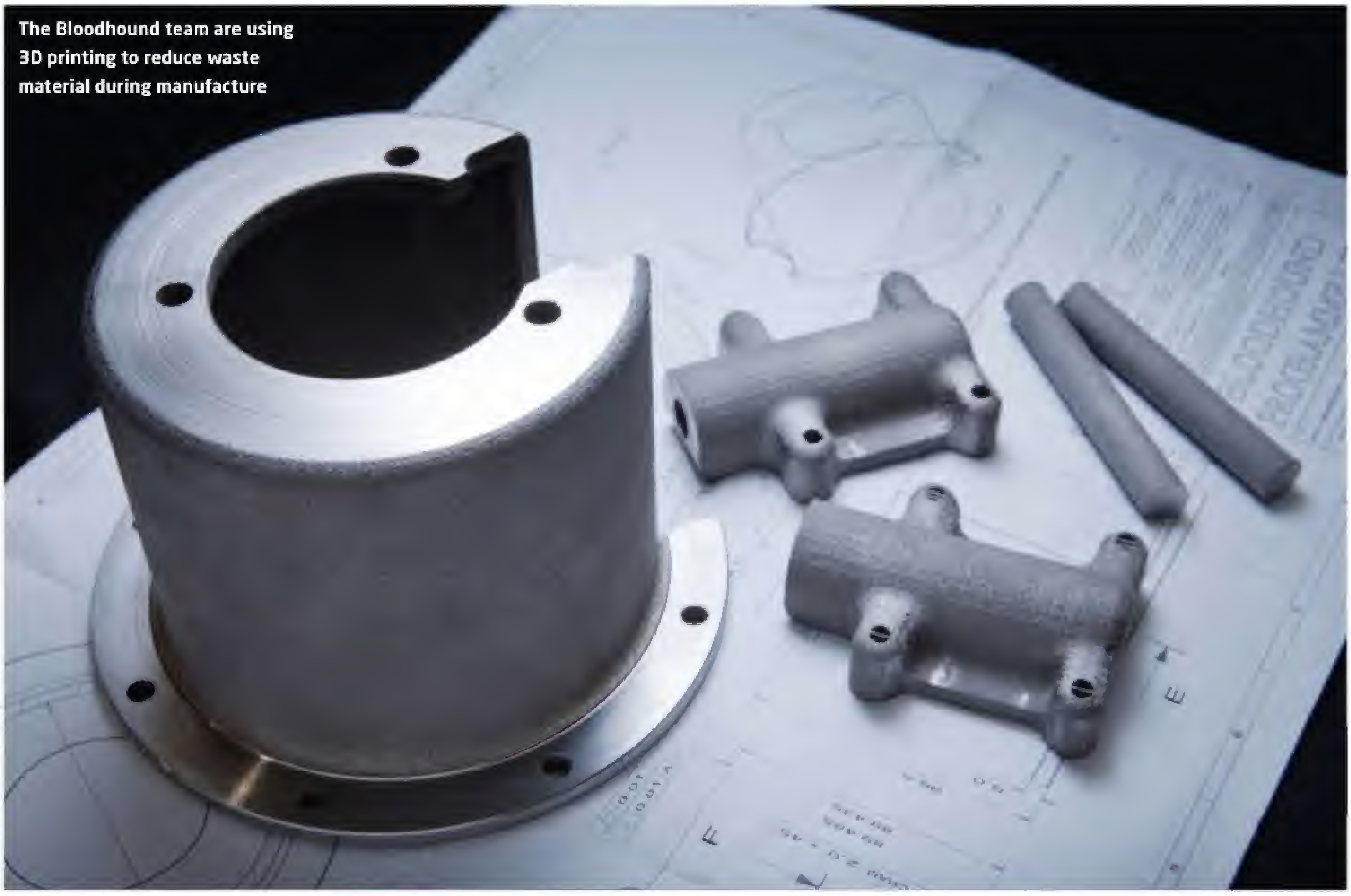
The Bloodhound team plans to use new materials in Green's clothing, developed by Italian manufacturer Alpinestars, which is completely fireproof, as opposed to being made from fire resistant materials such as Nomex.

The FIA Institute is working with Alpinestars with a view to creating the next generation fire suit for drivers. For the Bloodhound team, the advantages of a fireproof suit are clear – at 700mph, it would take Green 45-50 seconds to stop the car, and if it was on fire, it would also require time for the rescue and recovery team to reach the car and help to extinguish the flame. The suit is flexible enough to allow Green to egress without hindrance, but it does currently have the disadvantage of weight.

'The suit is fireproof, not fire resistant,' says Mark Chapman, chief engineer for the Bloodhound project. 'You blow a 1500degC flame over it to clean it, for example. Where Nomex will char and become brittle, this stays flexible, moveable, and has high degrees of insulation. This material is fireproof, and flexible so you can still move and get out of the fire.

'We looked at an ejected module, but at those speeds the safest thing to do is to keep the car in one piece and stop it.'

Cockpit design has also been carefully considered to reduce the risk of fire. 'The electronics and batteries are in the cockpit,' continues Chapman. 'An electronics fire is predominately smoke. Andy will have enough



The Bloodhound team are using 3D printing to reduce waste material during manufacture

PHOTOGRAPHY BY STEFAN MARJORAM

air for three runs. Even if every electronics module fails, he has air, the car could still be stopped safely, you could still deploy the parachutes. We have done enough FEA to make it work. Inside the cockpit he is as safe as he is ever going to be. In the back, we have the fire suppression that you would normally find in a fighter jet.

'We borrow a lot of technology from motorsport, but here it's a combination. We're borrowing from F1, fighter and – I suppose – spaceship.

'We're using stressed skin in steel, for example. Aluminium would be strong enough initially, but with the sonic shock blast from the front wheels, you could live with it for a couple of runs, but then would have no material left and we would see failures.

'We are stacking lots of knowns and taking them to their boundaries. We are really pushing some of the aluminium. For the wheels we are using an alloy called 70-37 and we have traceability from first melt. A lorry turned up at Otto Fuchs with six tonnes of pure liquid aluminium just for us. From there we add the ingredients that we need, blend that, inspect it, make the cast material, forgings, and then we make the wheel and spin it.'

Top: the lower structural chassis of the Bloodhound has been built using steel and aluminium Above: the cockpit is made from composite material, but many of Bloodhound's structures will be metal

METAL HEADS

Although the cockpit is made of carbon fibre composite, F1 technology that has allowed the team to start building the safety cell already, the team is looking for alternative structures in the nose section of the car which will have to withstand the pressures of supersonic travel, on multiple runs, without deformation.

The team is turning more to metal technology than carbon composites to find alternatives that could, ultimately, find their way into helmet design.

Currently, a carbon helmet that has suffered an impact, such as being dropped onto the floor, or an accident,will effectively be written off, unless it can be x-rayed and checked that there are no cracks in the structure. The Bloodhound team is working with aluminium trusses to absorb heavy impact and spread the load through the structure, a system that could be used to improve helmet safety in future.

'Following an impact in composites, it goes through the structure and cracks from the inside,' says Dan Johns, lead engineer of advanced manufacturing. 'If you have a honeycomb structure where the honeycomb is designed as an engineered structure, the impact can come in and send it all the way around rather than a single place. It is a way that you can make lightweight structures that can withstand a heavy impact.'

Using 3D printing, more complex designs can be used as structures are built. 'Where composites have got a tricky shape, you can't get tooling in,' says Johns. 'With [metals], you can optimise with the lowest volume of material, and make complex structures. You gain on carrying minimum material for carrying loads. You cannot do that with composites. Composites are limited by the processes to make them, and we're still in the early days of the technology. We have 2000 years knowledge of metallics, and 50 years of composites. Metallics isn't dead – aerospace is ramping up its interest in metal again because you can now make things in a more efficient way over machining, and you can gain on lighter weight.'

GEARING UP WITH ABC

Thanks to an impromptu meeting at the Autosport show in 2011, ABC Autosport Bearings and Components – the Shepperton, UK-based supplier of bearings, lubricants and adhesives – have gone on to become a key support partner to Bloodhound.

ABC sales manager Lee Sinclair says: 'James Painter from the Bloodhound project visited our stand, looking for assistance with the design and development of the bearings used within the F1-inspired gearbox.

'Having previously dealt with ABC on some of his own projects, James knew that he could trust our technical knowledge and experience from F1 to karting. Within a short time, we had agreed on the standard bearing ranges to be used, only changing one to the C3 version especially for the anticipated increase in temperature.

'The only other alteration from the original list of bearings was a change from an "open" type of super-precision ball bearing, which wouldn't have got sufficient lubrication within the gearbox. Therefore a "sealed" version was advised and selected instead. It's been great working with the Bloodhound team.'

Thanks to the link-up with ABC, the Bloodhound now features FAG ball bearings, INA ball bearings as well as FAG/BARDEN Super Precision ball bearings.

"In the cockpit, Andy is as safe as he is ever going to be. In the back, we have the fire suppression you would normally find in a fighter jet"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Ready for lift-off

Peugeot Sport's new R5 rally car might not be a showcase for state-of-the-art tech, but it's shaping up to be a promising, versatile and cost-effective option for privateer teams

Peugeot Sport Auto Essais 208 R5 taking flight in Riboux, December 2012

CLAUDE SAULNIER/AGENCE S PRESSE

BY MARTIN SHARP

Peugeot Sport planned originally to homologate its 208T16 R5 contender in October this year, but that target date has now moved to 1 January 2014. FIA R5 regulations create 'affordable' WRC2-competitive rally cars through cost-capped components - and restricted re-homologation options.

While M-Sport's Ford Fiesta R5 (see *RCE23 N9*), homologated in July 2013, has stolen a six-month lead on the Peugeot and is the first R5 car to win a rally, the French team opted to make sure all its sums were correct before hitting the stages in 2014.

'The R5 rules are very tough in terms of the possibility of changing some things after - we cannot re-homologate many things,' explains Bruno Famin, Peugeot Sport director: 'There was no big interest to homologate on 1 October because the season is almost over, as it were, and we preferred to take a little bit more time to finalise all the definitions to homologate something better and take three more months for that instead of selling a couple of cars more this year but without an interest. It was just a pure consequence of the R5 rules.'

It is perhaps also relevant that while Peugeot Sport engineers based their initial R5 planning and design work on the 208 model exclusively, it later became their task to incorporate their designs into the Citroën DS3 model, the R5 rally version of which is now planned to be homologated on the same date as the 208T16. This was originally to be three months later for some unexplained reason - but PSA 'knows best'.

Both cars are designed by the engineering team at Peugeot Sport's Velizy HQ with the philosophy that the two PSA R5 rally cars are mechanically identical.

Such a tactic provides evident cost benefits to privateer teams, given the ensuing economy of scale deriving from the procurement and stockage of the same parts for two rally cars - all competition parts for the DS3 R5 and 208T16 will be branded PSA Peugeot-Citroën. There is also the further benefit that extended development and testing programmes must contribute to useful R5 rally cars 'out of the box' - particularly considering the R5 re-homologation restrictions.

The 208T16 engine is tilted rearwards by the maximum allowed 25 degrees, with its crankshaft axis located at the most favourable legal R5 position -standard height, 15mm further toward the rear. The basic unit is that seen in the 208 GT1 and RCZ coupe, but just the cylinder block and head remain in the R5 rally car. Valves, pistons and rods are unique, as are the camshafts, driven by the standard toothed belt. Somewhat unusually for a rally engine, variable valve timing is retained on the inlet side, although Famin points out

rationally that, for a customer rally engine, there are advantages: 'We use it on the 208 R2 and it's a plus, and in terms of flexibility it's a good point. It's more complex obviously, because you have to make the ECU able to drive everything, but it's a good point.'

While the Fiesta R5 runs a bespoke forged steel crankshaft, Peugeot Sport has plumped for a machined standard production cast crank. Here again, this is because of the R5 rules: a bespoke crank must weigh no less than 12kg, while a crank derived from the production assembly can be the specified – lighter – weight of the standard unit. Famin: 'We are quite confident that the standard crankshaft is OK so far. Up to now we have had no problem at all on that part – we were going for the lower weight.'

The entire – regulation five forward speed – four-wheel drive transmission is provided by 3MO Performance, a French company set up by ex-Sadev engineers. Its hydraulic handbrake-actuated rear drive disengagement mechanism is similar to that in the 207 Super 2000.

But at Velizy, engineers were not able to stick exactly to the brief of identical mechanical specifications for the 208 and DS3 R5 cars. This was for a couple of reasons: the production 208 has a longer wheelbase and the wheelhouse spaces are different in each car. Hence the 208T16 propshaft and fabricated stainless steel tube exhaust system is longer.

As for the requirement for the suspension system to be exactly the same for both cars? 'That's one point where we have to be careful, says Famin. 'We are limited there.

'The problem is, we started first with the 208 and the two cars are very similar – or identical, except for the wheelbase. Then, however, when you start designing in detail, that which is supposed to be very, very similar, maybe it is not so similar. Sometimes we had to redesign some parts a little bit to make sure that

ANDRE LAVADINHO/AGENCE S PRESSE

The Peugeot Sport 208 rally car before (top) and running in (above) Rallye Ypres, part of the European Rally Championship, May 2013

everything was the same for the DS3 and the 208, so it was a little bit more complex than for other manufacturers.'

Similarly to WRCars, the R5 wheelhouse area is free. But unlike WRCars, R5's headlamps must be standard and in the standard position, which M-Sport found restricts front wheel travel on the Fiesta R5.

Famin confirms this also to be the case for the 208T16 and DS3 R5 suspension design: 'Yes, the standard headlamp position is one point where we have to be careful. We are limited by that. It was a point we checked because it's one area where the DS3 and the 208 are a bit different and then we have to find the best solution. We wanted the suspension to be exactly the same and we took it into consideration. So it is one limiting factor, but not much.

'We had to redesign part of the suspension to maximise the travels – in compression and rebound because of the commonality with the DS3. And I think we have designed something quite well.'

TESTING TIMES

The team has tested the car on gravel and tarmac extensively through 2013, during which it was found that improved engine flexibility would be preferable. They are using a smaller turbocharger than originally specified, from a German manufacturer's vehicle, together with an improved intercooler.

'The key point with this kind of engine when you have a turbo and an air restrictor is not the bigger level of power, it is the possibility of using the engine, and sometimes a bigger turbo is not the best,' says Famin. 'You have to find a good compromise between the range of use and the power.'

Peugeot Sport was involved in discussions with the FIA at the very beginning of the R5 regulations, taking cost limitations into consideration at all times during the design process.

Yet the mid-2013 FIA hike of minimum R5 weight from 1200kg to 1230kg came as a pretty unpleasant surprise: 'When the 208 and the DS3 are already designed to a weight of 1200k, and they say "We shall increase the minimum weight for cost reduction" – I just do not understand at all. It's just too late. Maybe it was a good idea, but it's just too late. It doesn't take into consideration the work already done – the work we have done to be at 1200kg; to allow all our customers to be with a 1200kg car,' says Famin. He also emphasises that being at the lower weight is better than having preferable ballast/weight distribution at a higher minimum weight.

This weight increase may not deter wealthy teams from fitting expensive lighter items such as seats and batteries, yet Famin is not concerned about this: 'People who have money will always spend money, but for me it's not a big issue,' he says. 'The possibility of spending money is very limited in the R5 rules. It exists, but not much.

'For example, compared to the cost of a seat, you don't have limitations on testing. If somebody wants to test with a car every day, he will test every day and the cost will be tremendous. Then the cost of having a specific seat is nothing.'

Test drivers are positive about the 208T16. Peugeot Sport's director echoes their feelings – confident that the extended development his team has put in to encompass two models has not cut corners. 'In fact it's not a compromise,' concludes Famin. 'I believe that we succeeded in designing something for both cars. At one time we were afraid to have to do a compromise, but in fact now I think we have designed something quite good for both.'

"The key point with this kind of engine is that you have to find a good compromise between the range of use and the power"

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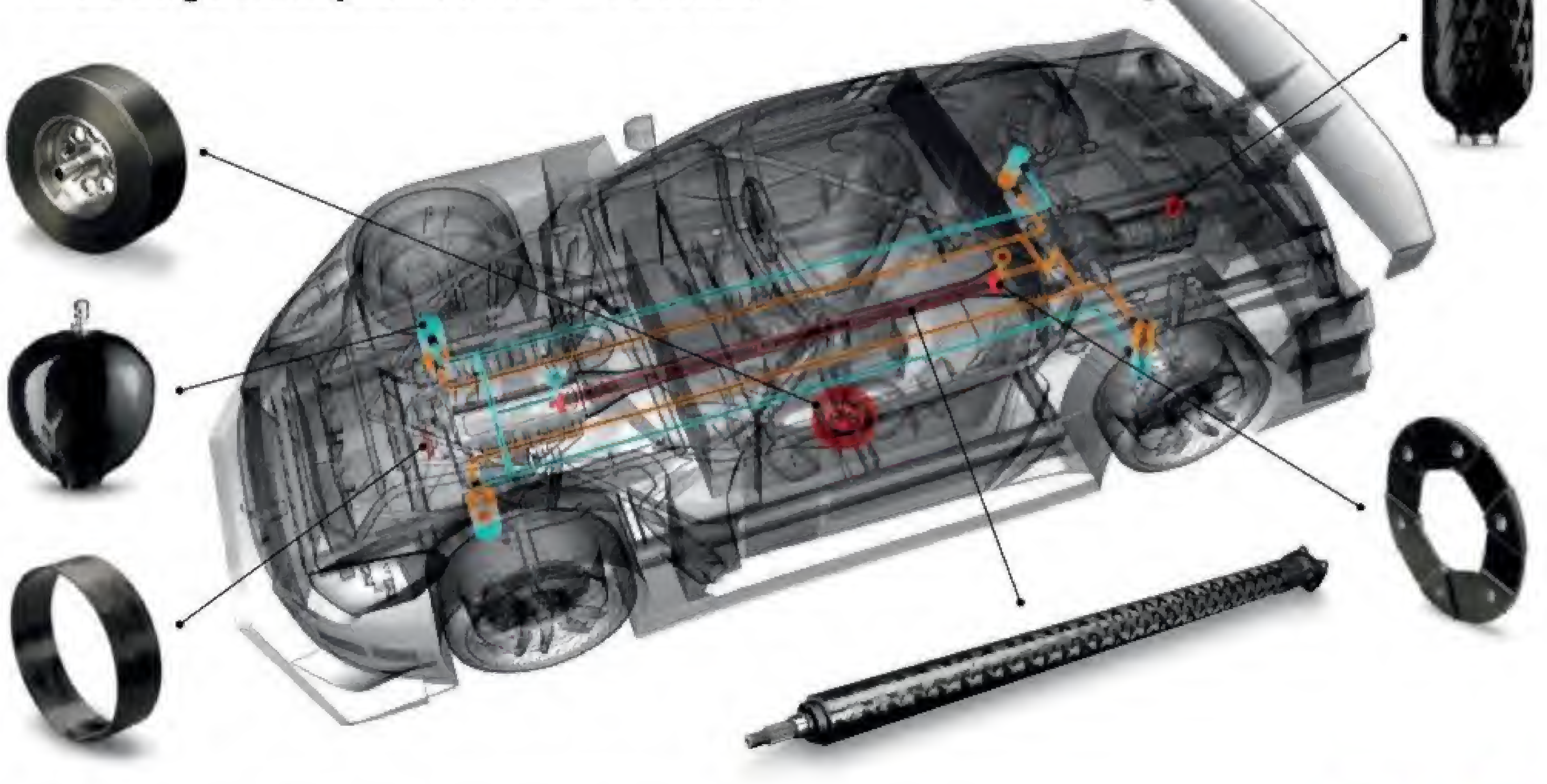

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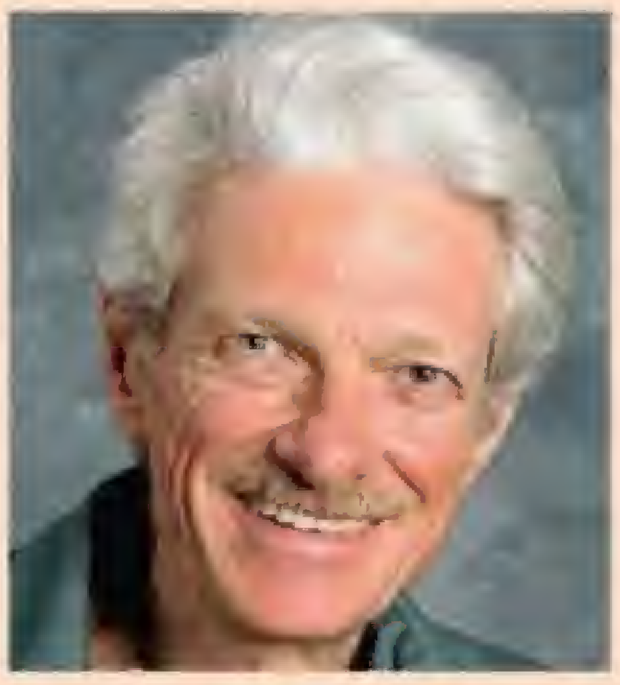

Mark Ortiz Automotive is a chassis consultancy service primarily serving oval track and road racers. Here Mark answers your chassis setup and handling queries. If you have a question for him, get in touch.
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Roll testing and suspension camber

The perils of rig testing and tyre compliance – and why approximation can prove to be the best way forward

QUESTION

When we run a roll test on the K&C rig, we roll the chassis through some pre-determined roll angle. As we do so and weight transfers, the loading tyres naturally compress and the unloading tyres rebound. Based on very accurate measurement of the wheel centre heights in this test, we are able to calculate a 'suspension roll angle' which subtracts the roll angle due to tyre compression away from the total chassis roll angle. Currently, we generate a plot of camber angle vs suspension roll angle.

However, I had one customer suggest that the camber angle also needs to be corrected, so we need to report a 'suspension camber angle' which would be the absolute camber angle minus the tyre compression roll angle.

This may make sense because the chassis to which the control arms are attached is rolling through an excess roll angle due to tyre compression. It is further suggested that the 'suspension camber angle' found in this way would match up with a rigid body kinematic model of the suspension.

I can see the logic of this but find it curious that no one has mentioned this before. For example, it's not something that Anthony Best Dynamics reports in their post-processing. What do you think? Does it make sense?

THE CONSULTANT SAYS

This question comes from my friends up the road at Morse Measurements in Salisbury, NC (www.morsemeasurements.com). They offer kinematics and compliance (K&C) testing to the general public. This is a very useful service that was previously only available to (or through) major manufacturers' engineering departments or – more recently – very well funded race teams.

The idea that there is a camber change component as well as a roll component due to tyre compliance definitely does make sense. And the tyre compliance camber change should be identical to the tyre compliance roll angle, since there is no camber recovery in tyre compliance roll.

The camber change due to tyre compliance, plus suspension roll, minus camber recovery due to geometry, will not necessarily equal measured camber change on the rig. That's not necessarily bad, however. In fact, it's a cloud with a definite silver lining. The difference will be camber change due to non-tyre compliances, and that should be a very useful thing for a client to know. Indeed, one of the main reasons for doing K&C testing is to evaluate compliances.

Since we generally buy our tyres, and run them at whatever pressure gives best grip, we generally just live with whatever tyre compliance we get. Trouble is, without rig testing we don't know what that tyre compliance is. Even with rig testing, we only have a decent approximation, because the tyre will act a bit different at speed and temperature on the track than it does sitting still at room temperature on a rig. But that decent approximation is still much better than no measurement at all.

For most forms of racing, we try to minimise other compliances, especially ones that cause camber change. In passenger vehicles, we accept camber compliance as a necessary evil, in order to get the noise, vibration, harshness, and stiction reductions that come with rubber bushings. In either case, we want to know what amount of camber compliance we have, from the pieces that we have some design control over. By accurately measuring the component due to tyre compliance, and subtracting, we can at least know the aggregate compliance from all the other parts.

We can then either use intuition and educated guessing to target areas where we think rigidity could be improved, and test again, or do further rig testing with additional measurement and instrumentation to pinpoint where the biggest or most easily remedied deflections are occurring.

A KD rig allows everything from torsional stiffness to toe changes to be measured – but thought is needed when it comes to the 'suspension camber angle'

Effects of driveline offset

Why torque arms affect roll moments – but the driveshaft and pinion don't

QUESTION

If the drive-line is offset significantly – let's say to the left as in a super modified – is the moment applied to the axle distributed out to the contact patches using the asymmetric drive-line centre to contact patch centre line distance?

This would yield very dissimilar reaction forces at the left and right contact patches – so is this line of thought correct? And if this is the case, what are the implications – if any – on calculating the sprung mass roll reaction and chassis roll moment distribution front to rear for calculating torque roll?

This may be obvious – or am I simply confusing the difference between a force couple and a moment applied asymmetrically to a beam?

THE CONSULTANT SAYS

The location of the driveshaft or the pinion does not matter at all. The location of the torque arm is what matters.

It is the location and nature of whatever transmits axle forces (both torque and thrust) to the sprung structure that determines what roll moments the system creates. Location of the driveshaft only matters to the extent that it relates to that.

If the driveshaft exerted a vertical force where it connected to the axle, its lateral location would matter. But the driveshaft is designed so it can only transmit rotational forces. If we try to push the axle laterally or vertically with the driveshaft, the universal joints bend. If we try to push the axle longitudinally with the driveshaft, the splines slip.

When we have a beam (such as the axle) supported on two points (such as the tyres) and we apply a purely rotational force to the beam, it doesn't matter where along the beam's length the rotational force is applied. The sum of the forces at the support points will not change when we apply the rotational force, and the change in their difference will be the rotational force times half their spacing.

It's a misconception that the pinion shaft applies a jacking force to the suspension, and therefore its lateral location affects torque roll. It's true that in a conventional rear end, the pinion shaft does exert an upward force against its bearings. There is an equal and opposite downward force at the differential carrier bearings, and the sum of the vertical forces is zero. There's an offset in the lines of action, and therefore a couple, and a corresponding moment, or torque. The torque tries to rotate the axle housing rearward, and there's a corresponding equal and opposite torque forward at the ring gear, axles and wheels, which propels the car. The rearward torque on the axle housing acts through the suspension, and the suspension can be arranged to produce roll moments in response.

The driveshaft also tries to roll the axle to the left, and roll the sprung structure to the right. This creates torque wedge and torque roll. The mechanism used to react axle torque can be arranged to counter the effect of driveshaft torque, or augment it.

Stockcars, such as this BK Racing NASCAR entry, feature live rear axles

LAT

But neither wedge change due to axle torque or driveshaft torque are influenced by the lateral whereabouts of the driveshaft.

In a torque tube rear end, the location of the torque reacting mechanism is linked to the driveshaft location. In a torque tube design, axle torque is transmitted to the sprung structure by a tubular beam surrounding the driveshaft. There's a large hollow ball – or spherically radiused formation – at the front of the torque tube, which sits in a cylindrical bore. There's generally only one universal joint, arranged to be concentric with the ball.

The shaft is then splined to the rear end input shaft, and also has splines at its forward end to absorb plunge. Since the tube encloses the driveshaft, it has to be where the driveshaft is.

A beam that acts similarly but doesn't surround the driveshaft is called a torque arm or lift bar. It can have a sliding connection to the sprung structure at its front end, as a torque tube does, but more commonly it has a drop link. A drop link only constrains the arm end vertically, and not horizontally. A ball or bushing can create rear steer or bind, depending on the geometry of the axle locating linkage. A rigid drop link is the usual choice in supermodifieds. In dirt Late Models, a coilover is generally substituted for the drop link. In IMCA-style modifieds, a big coil on a slider is a common choice.

Whether the drop link is deliberately made compliant or not, its plan view location is what determines the magnitude of the jacking force the arm creates, and where the jacking force acts. Where the arm attaches to the axle doesn't matter, nor does the height of the drop link or arm end. If a torque arm is used at all.

In supermodifieds, the rear axle is generally a closed-tube quick change with a spool and wide-five hubs (five lug studs, on a 10.25in bolt circle). There are generally two disc brakes, with the calipers on birdcages. Two parallel, equal-length trailing links run forward from each birdcage to the frame of the car. The trailing links locate the axle longitudinally, and react braking torque.

The centre section of the rear end is by no means in the centre. It is drastically offset to the left. The driveshaft runs just inboard of the left rear tyre. The driver sits a bit to the right of that. The driver's right shoulder is left of the track midpoint. The engine is alongside the driver's legs, tilted to the left.

Between the driveshaft and the driver sits the torque arm. Because the torque arm is so far left, it generates lots of rightward roll and wedge increase under power. This is basically a good thing, because a car as left-heavy as a supermodified tends to be loose on exit, and a lot of torque wedge counters that. However, the torque arm overcompensates, and the car actually has a power push, which has to be compensated for with the rest of the setup. The car is then freer than we would like before the driver applies power.

Personally, I'd use a trailing link or pull bar rather than a torque arm, and provide multiple mounting points for its front pivot, to adjust the angle of the link.

It's a misconception that the pinion shaft applies a jacking force to the suspension, and therefore its lateral location affects torque roll

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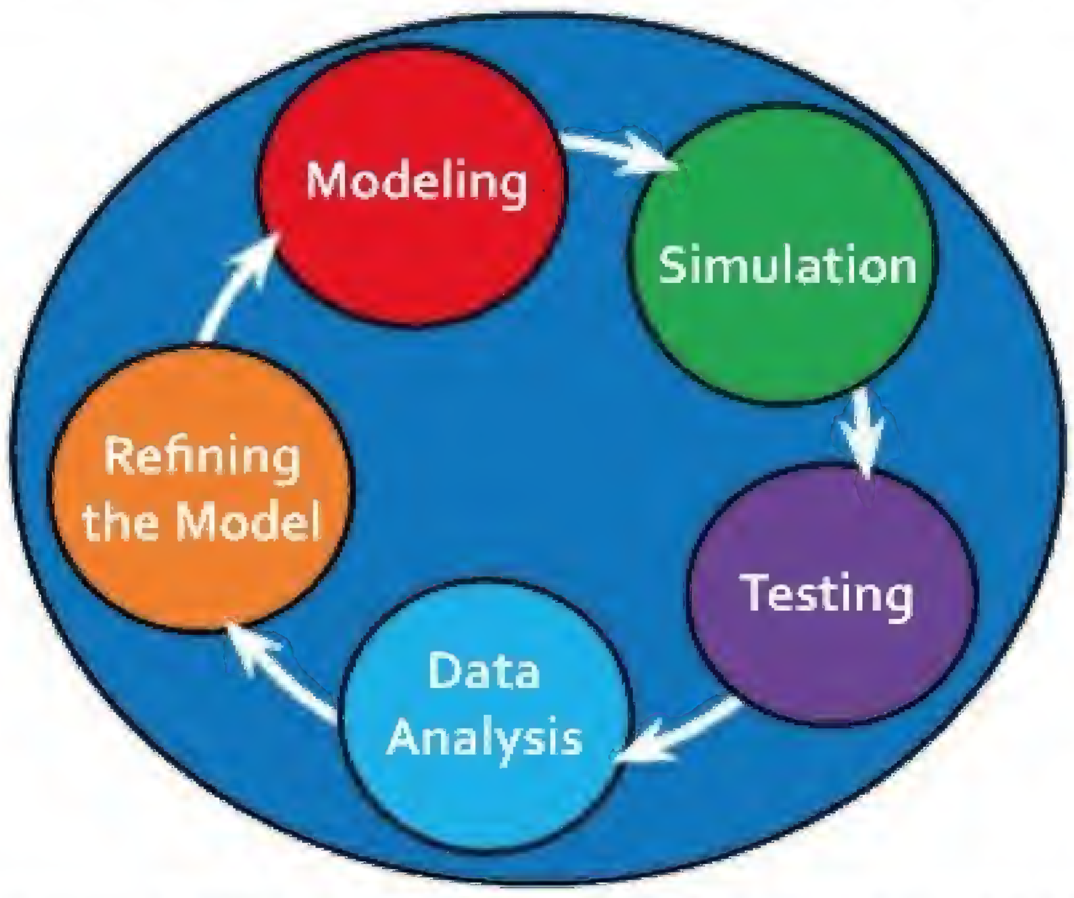

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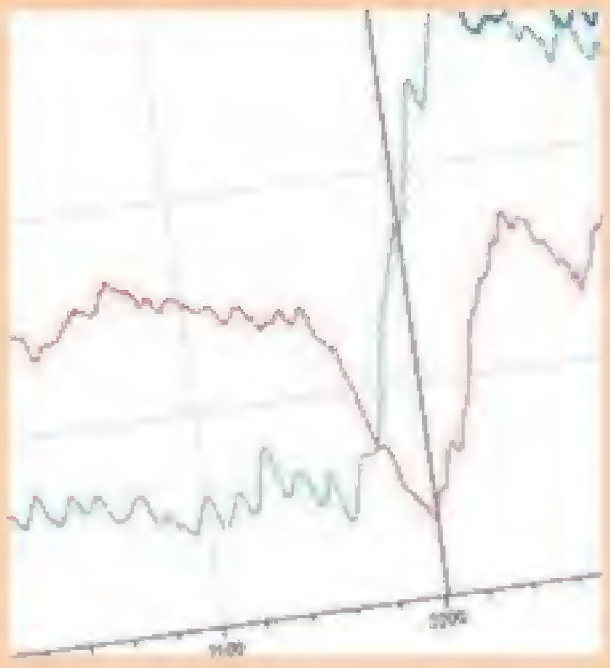

Databytes gives you essential insights to help you to improve your data analysis skills each month, as Cosworth's electronics engineers share tips and tweaks learned from years of experience with data systems

To allow you to view the images at a larger size they can now be found at www.racecar-engineering.com/databytes

Wiper control

For drivers, the ability to see where they're going is useful. And yet wiper motors are still often added as an afterthought...

When designing a racecar system architecture, there are many auxiliary systems that the driver needs to interact with but are often forgotten or written off as being trivial. The amount of times where wiper motors or headlight control is implemented as an afterthought in a racecar system is somewhat surprising.

In many instances, these auxiliary systems are taken straight off road cars and as such expect signals over CAN or from a direct switch. Data systems and power control modules for racecars should be able to provide these signals without any problems and it should be possible for the end user to program the functionality to best suit the application. In the example of a wiper motor, the ability to start a single wipe of the windscreen with the wiper stopping at the exact same spot where it started all initiated with a single button press may sound trivial in the first instance, but when you need to program a control strategy from scratch it may prove slightly more complicated. There are many different types of wiper motors that require different control inputs, some use a LIN bus, some use CAN and others are wired directly to an output, while some have a form of feedback like the point where the wipers are expected to park.

Looking at the first case where a LIN bus is used to provide communications with the wiper motor, this assumes that the car control systems are capable of communicating with a LIN bus. In this case it is necessary to provide a strategy for the motor to turn on using a single button, but with two states. First a single wipe initiated by a single press of the wiper button, and then a continuous operation until cancelled initiated by a press and hold of the wiper button. The function required is relatively simple, as only the fast wipe setting will be used. Generally, if the wipers are needed in a racing environment they will need to move fast. The control strategy is broken up into two stages - first of all, a simple timer to see how long the wiper button is pressed for. An example is shown in **Figure 1**.

Then a channel that determines what state the wipers should be in based on how the wiper button is pressed - see **Figure 2**.

The control channel is then referenced in the LIN wiper control in order to transmit the information to the wiper motor - see **Figure 3**.

The control channel is then referenced in the LIN wiper control in order to transmit the information to the wiper motor. This is shown in **Figure 4**.

Figure 1

```
@a0 = choose ( [SW16 Wiper] , choose ( @a0==60000 , 60000, @a0+0.01 ) , 0 ) ;
@a0   //in this case the channel [SW16 Wiper] is the momentary input of the wiper switch
```

Figure 2

```
@a1 = choose ( ( [SW16 Wiper] > @a2 ) , 1 , 0 ) ;
@a2 = [SW16 Wiper] ; //these two lines work together as a rising edge detect for the wiper button
@a3 = choose ( @a1 == 1 , choose ( @a3==2 , 0 , @a3+1 ) , @a3 ) ; //uses the above to change the state from 0 to 1 or 2 to 0
@a4 = choose ( [Control Wiper Timer] > 1 , 1 , 0 ) ;
@a3 = choose ( ( @a3 == 1 && @a4 == 1 ) , 2 , @a3 ) ; //the timer channel is used to change the state from 1 to 2
@a3 = choose ( ( @a3 == 1 && ![SW16 Wiper] ) , 0 , @a3 ) ; //checks to see if the button is still pressed and if not changes the state from 1 to 0.
@a5 = choose ( ( @a3 == 1 || @a3 == 2 ) , 3 , 0 ) ; //This is the value sent over the LIN bus, in this case a value of 3 is equal to a fast wipe action.
@a5
```

Figure 3

Figure 4

```
!([Control Fast Wiper]) && ([Wiper Park ] == 1) // here the wiper motor is turned off if both the control channels for the wipers are off and the wiper park signal is on
```

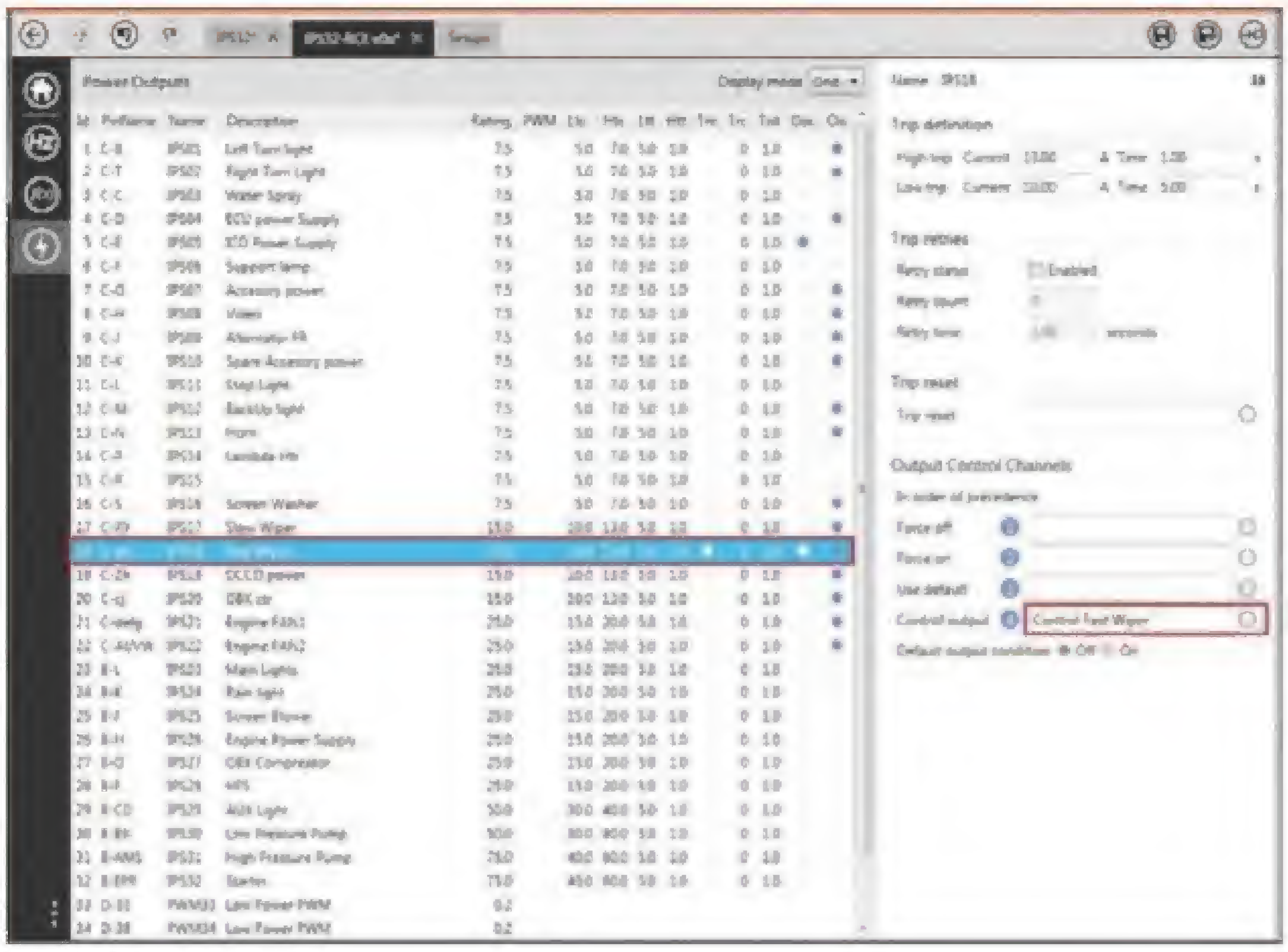

Figure 5

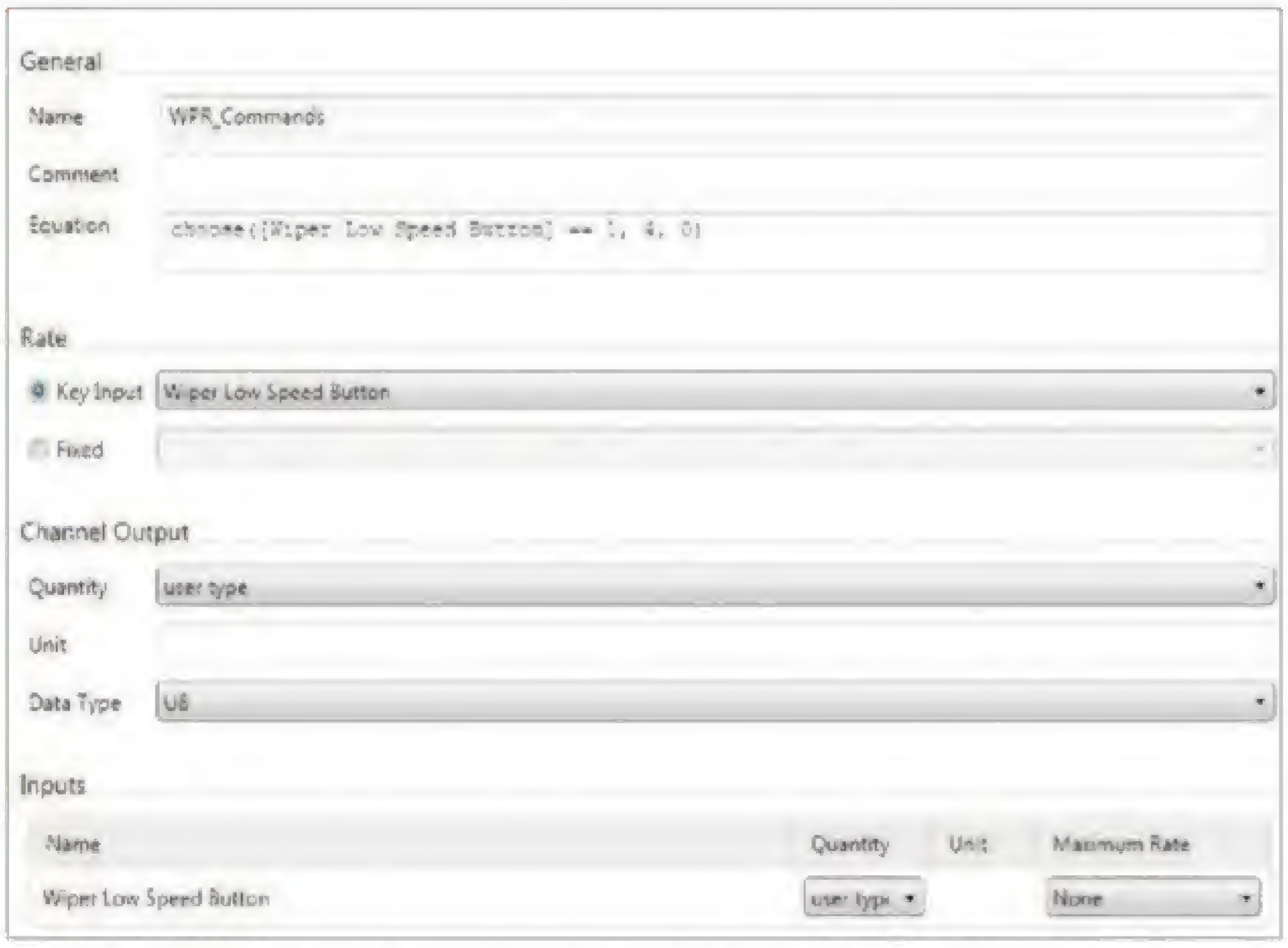

Figure 7: example of how a button press could be linked to a CAN control channel for a wiper motor

Once the control channels for the wipers have been written, it is simply a matter of hooking them up to the correct output pin on the power management system to allow it full control over the wipers. In **Figure 5**, the output control for fast wipers is linked up with the math channel [Control Fast Wiper].

If the wiper motor in use is on a CAN bus, it can be much easier to write the control channels as the wiper motor will have some intelligence already built-in. It can be as simple as writing the correct CAN encode stream and then all that is required for control is to set the correct bit to true using button presses or automated control. In **Figure 6** it was possible to replicate fully the functions of an automotive spec wiper motor with a CAN interface on a racecar. This opens up possibilities such as automated control using a rain sensor. In order to control the wipers, it is as simple as linking a button input to the correct bit in the channels [WPR_Commands] and [WPR_Int_Interval].

There are of course many things to consider when programming things like the wiper controls and different strategies will suit different types of racing and vehicles. Is it better to use one button for all modes or are multiple buttons better?

This will be dictated by the flexibility of the control system and should also be discussed with the driver as he or she will ultimately need to use this in anger. See **Figure 7** for an example of this.

Figure 6

```
<CanPacket Name="Wipers"
        Id="0x2c1"
        Endianness="Little"
        PacketType="Standard"
        BitNumbering="OSEK"
        Length="48"
        Rate="10" >

    <!--    bit 0 = Tip Wipe (stalk button)
            bit 1 = Interval position (stalk)
            bit 2 = Low speed wipe (stalk)
            bit 3 = High speed wipe (stalk)
            bit 4 = Front wash (stalk)
            bit 5 = Front wash status
            bit 6 = rear intermittent
            bit 7 = rear wash-wipe
      -->
    <CanPacket.Contents>
                <Channel Name="WPR_Commands"
                Start="8"
                Length="8"
                Default="0"
                TimeoutBehavior="ResetToDefault"
                Quantity="user type"
                Unit="user"
                DataType="U8"
                Offset="0.0"
                Gain="1.0"
                ScaledDataType="U8" >
                </Channel>
    <!-- 0 = low speed
         3 = 11 second interval
         5 =  8 second interval
         9 =  4 second interval
      -->
                <Channel Name="WPR_Int_Interval"
                Start="16"
                Length="4"
                Default="0"
                TimeoutBehavior="ResetToDefault"
                Quantity="user type"
                Unit="user"
                DataType="U8"
                Offset="0.0"
                Gain="1.0"
                ScaledDataType="U8" >
              </Channel>
        </CanPacket.Contents>
 </CanPacket>
```

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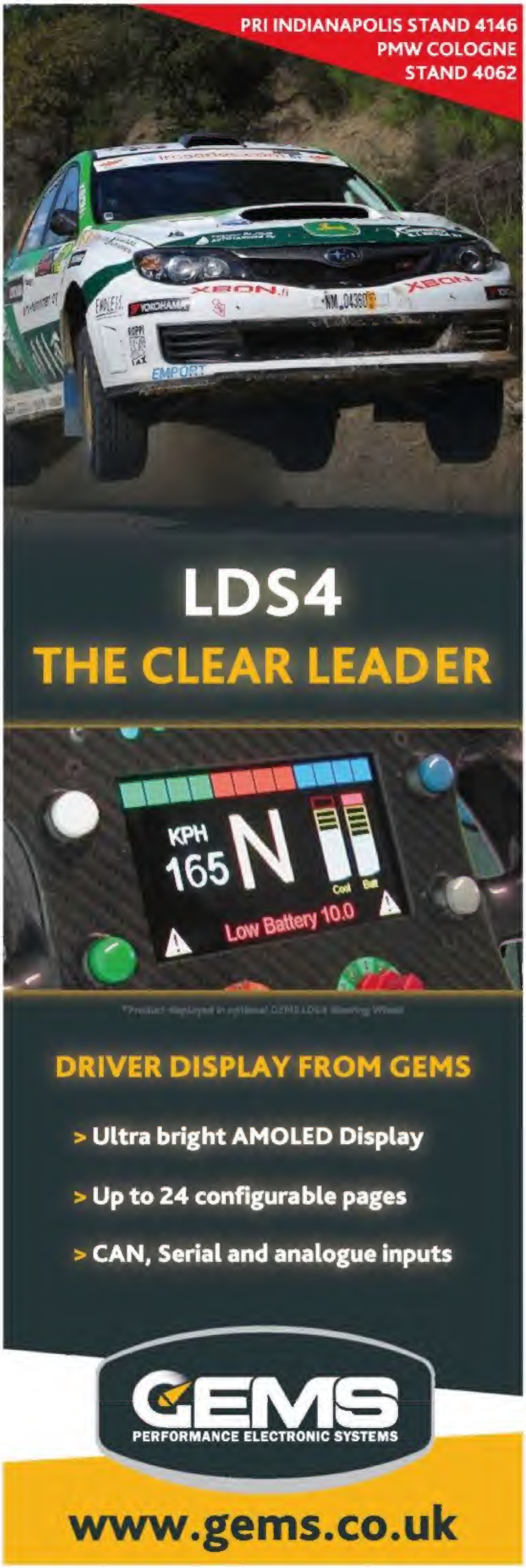
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Simon McBeath offers aerodynamic advisory services under his own brand of SM Aerotechniques – www.sm-aerotechniques.co.uk. In these pages he uses data from MIRA to discuss common aerodynamic issues faced by racecar engineers

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Striking a balance

Concluding our examination of a 1970s Lola T390 sports racer

Our time with the Lola T390 BDG is drawing to a close, and for our final instalment, we are looking at generating a better balance. Track testing before the car arrived at the wind tunnel had highlighted understeer at higher speeds, and the baseline wind tunnel runs demonstrated a shortage of front downforce.

In our previous two editions we have seen how increasing the rear ride height, blanking off the front radiator inlet and some variations on the end fences enabled the '%front' value, that is, the proportion of total downforce on the front wheels, to be increased from its baseline 10 per cent value into the 40 per cent region and above. The car's static weight distribution, with fuel and driver, was around 42 per cent front, 58 per cent rear, so the target for the aerodynamic balance was in the 37-38 per cent region to provide a stable mild understeer condition at 'aero' speeds.

Table 1: aero data after evaluating splitter end fences

	CD	-CL	-CLfront	-CLrear	%front	-L/D
Best option	0.531	0.538	0.246	0.292	45.7%	1.013

MORE DOWNFORCE

However, although getting into this balanced range proved relatively easy, a secondary aim was also simultaneously to generate as much downforce as possible. At the conclusion of our last episode, in which we examined a range of splitter end fence options, the best option, using extended rectangular shaped end fences and no intermediate fences, left us with the data in **Table 1**.

This configuration saw the highest level of front downforce achieved to this point. For practical reasons we did not have a longer splitter to try during the session, although that would undoubtedly add yet more front downforce. So with that in mind, and with the further constraint that modifications had to match those used in period on the T390, which seemingly precluded the use of dive planes, we looked next at adding rear downforce to find a balance. And the easiest way to do that was to add rear wing angle. The data and the changes in 'counts', where 1 count = a coefficient change of 0.001, are shown in **Table 2**.

Table 2: the effects of increasing rear wing angle by 2 degrees

	CD	-CL	-CLfront	-CLrear	%front	-L/D
+2deg rear wing	0.542	0.581	0.217	0.363	37.3%	1.072
Change, counts	+11	+43	-29	+71	-8.4	+59

By good fortune this 2-degree increase in wing angle brought the balance right into the target range, also generating the highest balanced downforce of the session so far.

Pre-session CFD had shown that the circular-section wing-mounting post created a substantial wake across the centre section of the rear wing, and the smoke plume confirmed that there was a stalled zone behind the wing post. The solution in CFD was to surround the wing post with a symmetrical aerodynamic section fairing, and the rear wing's performance improved remarkably. The hope was that such a fairing would enable the same level of total downforce to be generated with less drag, so as a rough way to try this in the wind tunnel, a pair of plates was taped to the sides of the wing post and joined in a sharp trailing edge behind the adjuster rod. The results are shown in **Table 3**.

Far from helping rear wing performance then, this change actually reduced rear downforce. Being brutally critical, the taped-on plates left in place the big circular leading edge radius of the wing post, and added a forward facing step - the thickness of the plates plus race tape - to both sides of the post. This probably broadened the post's

The Lola T390 as it arrived in the wind tunnel

This configuration of splitter end fence produced the best front downforce

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Table 3: the effects of adding plates to the side of the wing mounting

	CD	-CL	-CLfront	-CLrear	%front	-L/D
+ mount plates	0.540	0.560	0.225	0.334	40.2%	1.037
Change, counts	-2	-21	+8	-29	+2.9	-35

Table 4: the effects of taping over the front and side inlets

	CD	-CL	-CLfront	-CLrear	%front	-L/D
Tape over inlets	0.535	0.599	0.278	0.321	46.4%	1.120
Change, counts	-5	+39	+53	-13	+6.2%	+83

Table 5: coefficients on the Ligier JS49 in an 'aero balanced' condition

	CD	-CL	-CLfront	-CLrear	%front	-L/D
Ligier data	0.564	1.554	0.592	0.962	38.1%	2.755

wake, whereas a symmetrical aero-section fairing that extended ahead of as well as behind the post, would have narrowed or even eradicated the wake. So this was just one of those quick mock-ups that didn't sufficiently match the required shape for the benefits to be realised.

Regular readers will recall from our September edition an observation that air exiting the Lola's front-mounted radiator was neither ducted away nor directed along an easy escape route, and that this would be contributing front lift. Cooling had apparently not been an issue in track testing, and indeed some of the front inlet was taped over to prevent over-cooling. Taping over part of the front inlet aperture in the wind tunnel produced 45 counts of front downforce. So, to check how much lift the front cooling apertures were now producing in total, the last quick change of the session saw the whole front radiator inlet and the brake cooling inlets taped over. The inlets on the sides of the car were also taped over. **Table 4** reveals the results.

So the combined effect of the front and side inlet apertures, even with the central aperture already partly blanked off, was to generate 53 counts of front lift, and it's a fairly safe assumption that most of this came from the front apertures. Although converting all of this to extra front downforce through careful ducting (in a confined space) might be a tall order, this showed that there is clear potential to obtain more front downforce through work on this aspect. And balancing it with a small rear wing angle increase would be no problem.

This last configuration saw the highest total downforce of the session, and we said in September's Aerobytes we'd go back and compare the data to a modern 2-litre sportscar equivalent, the Ligier JS49 we tested in 2009 – see **Table 5**.

From having just a quarter of the Ligier's downforce initially, our session showed that the potential is there to increase that to a third. Such is 30 years' design progress…

Next month we start a new project with the University of Hertfordshire's Formula Student team.

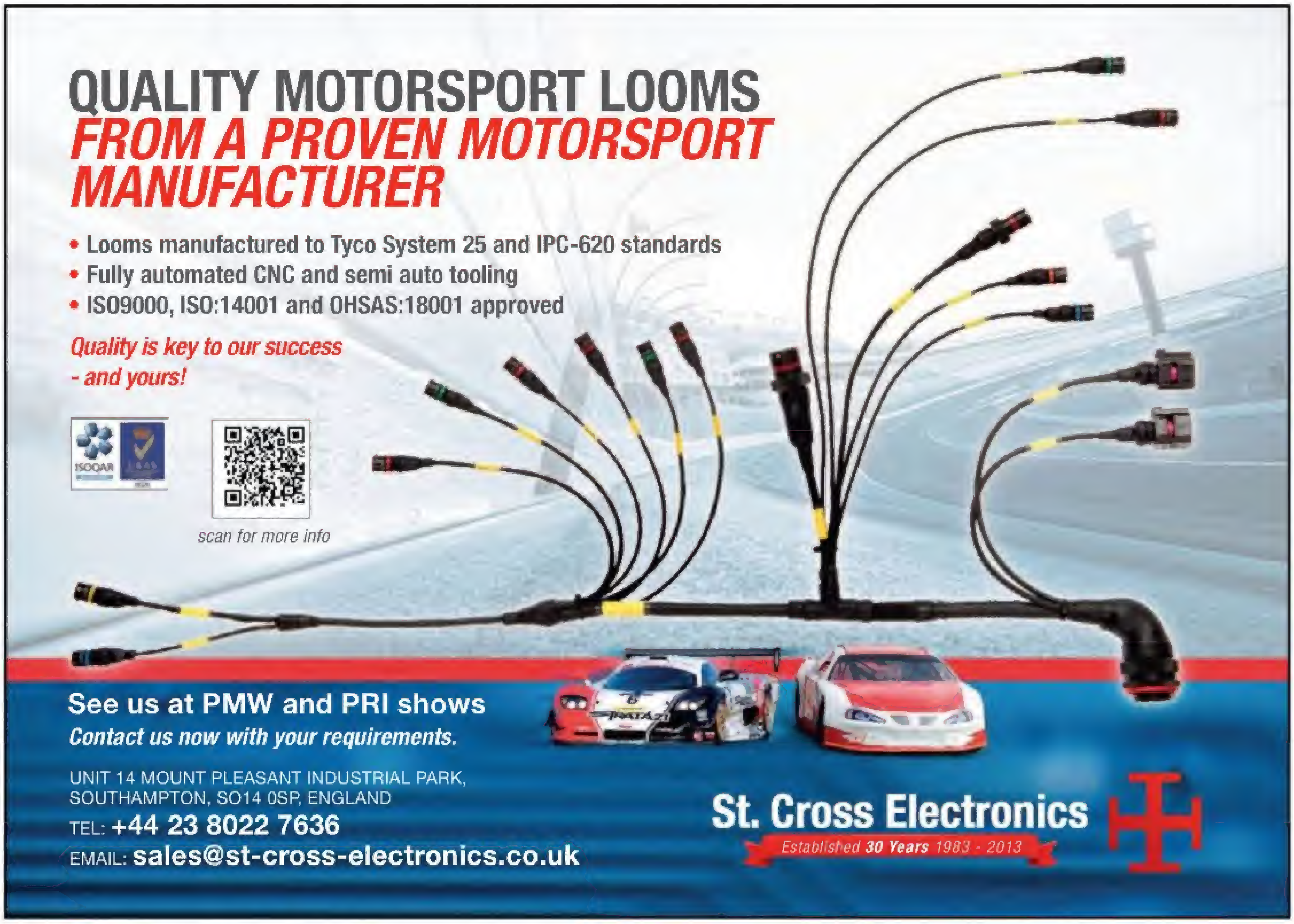
Racecar's thanks to Gerry Wainwright Motorsport

Increasing rear wing angle had the expected effect

Sometimes the best intentions can lead to unwelcome surprises…

The smoke plume highlighted a stalled area behind the wing mounting post

Taping up the front inlets showed potential for more front downforce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Tunnel visions

As aero importance has increased, so too has the need for accurate scale-model tyres during tunnel testing. And it's not simply a case of making racing models smaller...

BY MARCO DE LUCA

There is currently a lot of discussion about tyres in Formula 1. While understandable, particularly given some recent high-profile incidents, on the whole I feel that there is too much concentration on tyres when there are so many other technical aspects to a modern F1 car that deserve a similar level of scrutiny.

So instead, I'll try to offer a different perspective on F1 tyres - one that is normally confined to insiders. It concerns the scaled-down replica tyres adopted during the aerodynamic development of an F1 car. These are fascinating items that provide headaches to all the engineers, designers, technicians and workers who, on a daily basis, have to squeeze out the best aerodynamic performance.

As with any high-level formula running 'exposed' tyres, finding a good way to represent the complexity of a real tyre in all the processes involved during aerodynamic development is a huge challenge, and even more so when the overall tyre shape is supposed to change significantly. When discussing the 2013 spec, Pirelli motorsport director Paul Hembery said: 'We know that the changes we've made will have an influence on things like aerodynamics for the teams; tyres will deflect more, the rear tyre in particular.'

Before modern scaled-down tyre replicas were available for wind tunnel testing, the aero community I belong to used to deal with 'solid' tyres - made of nylon, carbon, aluminium etc - to equip their car-models for wind-tunnel aero tests. These were simple, round, solid and cheap tyres. Often, obsolete spec tyres were used while developing the car, and - admittedly - some were older than they should have been.

We were all perfectly aware of the limitations of this basic approach, but at the time our attention was taken by something other than tyre realism. In reality, it's only in the last decade that aerodynamics in F1 has become so sensitive and finely tuned that tyre realism has become a seriously considered issue. Rule changes are a big part of this, having progressively exalted the 'aerodynamic integration' of the un-sprung parts with the rest of the car - such as track narrowing coupled with front wing widening.

As the need for better tyre replication increased - supported by some milestone studies as those from Fackrell and Harvey in the early-70s - some low-cost alternative technologies were developed

Finding a good way to represent the complexity of a real tyre during aerodynamic development is a huge challenge

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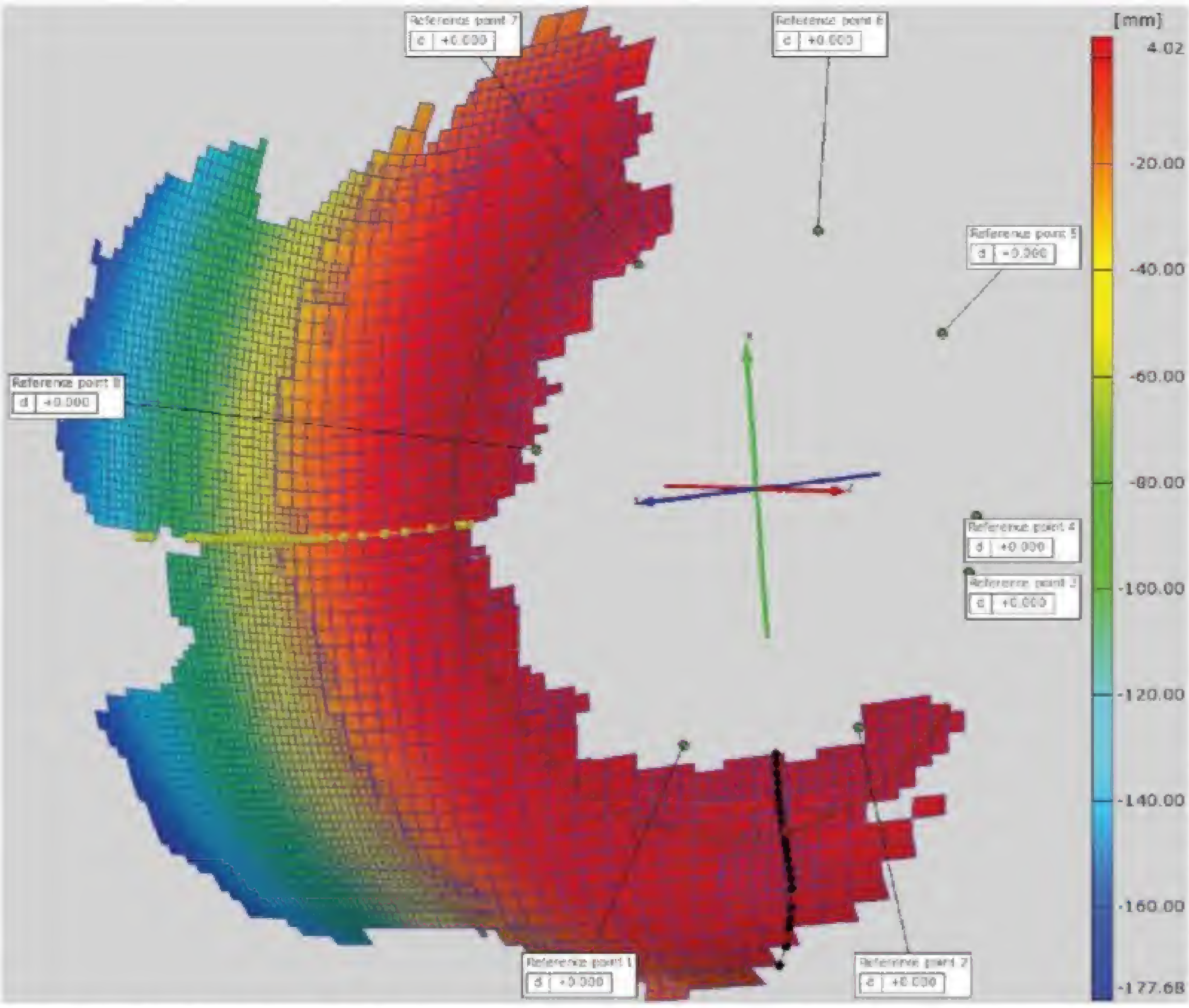


TOYOTA MOTORSPORT GMBH

Results from wind tunnel analysis of the sidewall of a rear tyre captured at the Toyota facility in Cologne

to help remove the limitations imposed by basic solid tyres.

A wide range of compromise solutions would be adopted, not just in F1 but also while developing cars that were somewhat less demanding in terms of tyre-fidelity (ie: road cars and 'covered tyre' formulas). These included:

- **Tread surrounded by a thin spongy belt**
- **Composite-made units with just a few plies in the tread zone, properly profiled, creating a structure able to slightly deform under vertical load**
- **Conical tyre designs to cope with high-camber setting**

The first two solutions were assumed to offer a more realistic profile of the contact patch (ie: the footprint of the tyre to ground) compared to the solid wheels. This aimed to better align the features of the flow surrounding this area to real-world situations.

Also, thanks to the (modest) lack of rigidity of the tyre tread, the aerodynamicists started to mitigate the corrections they needed to make to the scaled-down suspensions (nulling of camber-change induced by the suspension travel) in order to maintain the design contact-patch while changing rides and/or steering the front wheels.

The most visionary engineers dedicated some resources to precursory deformable tyres over 20 years ago. However, we all knew back then that a professional tyre manufacturer should have been involved. I personally carried out some laboratory attempts at the beginning of 90s but, unfortunately, my enthusiasm and 'vision' were not enough to counterbalance the lack of good results to sufficiently convince my bosses to continue investing in this technology.

The revolution eventually happened when F1 tyre suppliers started to supply the first prototypes of inflated, rubber-made, scaled-down replicas, nominally ready to behave like the full-scale reference shapes. Engineers involved in tunnel testing were - understandably - extremely excited about this. As a result, suspension systems were finally designed almost completely respecting the kinematics of the full-scale systems.

However, this good feeling was initially accompanied by frustration and stress when it was quite clear that 'dominating' the small, black shapes at our disposal were not quite so easy to work with as we'd assumed. I remember well how easily the first prototypes - beautiful replicas before running - were so quick to assume a dynamic shape completely dissimilar to anything close to our idea of a running tyre. I now recall that period as a great and forming experience, but thank God that it's in the past!

As normally happens in any interdisciplinary research, the introduction of this new technology inevitably boosted the progress in other fields of racing aerodynamics, with a huge overall benefit. And the benefits didn't end there - CFD came on massively during this period, and this method of calculation and simulation became increasingly involved to help us to better understand the impact to the aero performance that would come from tyre deformation.

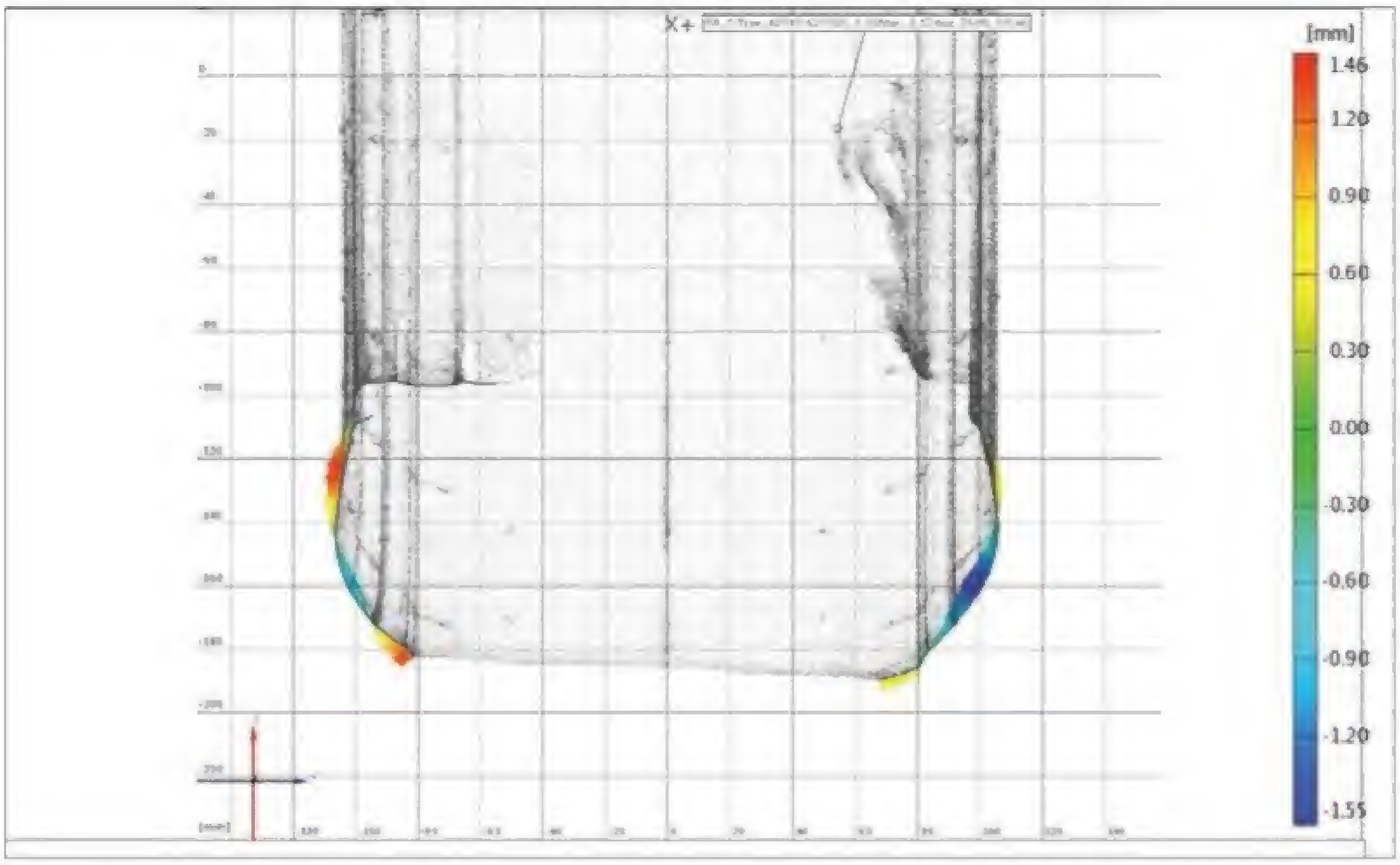
Collectively, our CFD colleagues were forced to raise their game by generating more sophisticated models and analysis tools to correctly simulate the complexity of the flow around the tyres, both steadily and unsteadily. The technology and know-how that originated from these efforts has been far-reaching, not just in racing, but throughout engineering as a whole.

To explain part of the reasons behind the initial troubles, please consider that tunnel tyres had to be designed respecting requirements that were - and indeed still are - counter-intuitive for engineers who were constantly focused to extract mechanical performance from the full-scale units.

Wind tunnel tyres need to offer a very long working life - quite the opposite to race tyres. Nowadays, a tunnel tyre-set

can easily last for a equivalent distance longer than a tour around the globe. At 50m/s of tunnel speed with an average run-time of – say – 8 mins, the model would cover an equivalent distance of about 24km each run. Correct tyre-management can easily extend the life of a single tyre-set above 1700 consecutive runs, which is the number at which a model would have virtually completed a lap around the world! You need to reach this level of endurance-capability, because the number of tyre-sets that a team can use each year is limited by sporting regulations. On a more practical level, however, tyre changes cost time better spent running tests!

Tunnel tyres also need to deliver low levels of grip. This lets you manage 'slipped' model conditions, without sending the car flying into the control room. There's simply no need to generate any serious longitudinal and lateral tyre forces during tunnel testing. Low levels of grip – vital to give you long tyre-life – will also help to minimise errors while extracting the aero component from the globality of forces generated by the tyre and registered by the force-sensors. This element is more important when dealing with Fx components, such as when assessing the drag. Too much low grip is not desirable, otherwise the slip-ratio – particularly in slipped condition – tends to be much higher than full-scale, exposing the experiment to the risk of losing the realism of any flow-features related to tyre rotation.



To make tyres 'squash' better in the wind tunnel, active loading systems are placed inside the model tyres

They also need to exhibit much lower vertical spring-rate than real tyres. This can be obtained through proper design of the tyre structure and very low levels of inflating pressure. Tunnel tyres have to deform like their racing siblings, but this happens under loads lower than those acting on a real tyre by a couple of orders of magnitude. If we exclude the modest aerodynamic contributions generated by the wheel-group itself, the vertical reaction at the contact patch comes from the mass of wheel+tyre assembly, in the order of 200-300N for each corner. This is the load you have to deal with to deform the tyre.

On top of this, to make the tyre 'squash' better corresponding to any peculiar car-manoeuvre simulated in the tunnel (braking, high- and low-speed corners, high-speed, etc) active loading systems are placed inside the modern wind-tunnel models. These are the source of additional

TMG'S TUNNEL TECHNIQUES

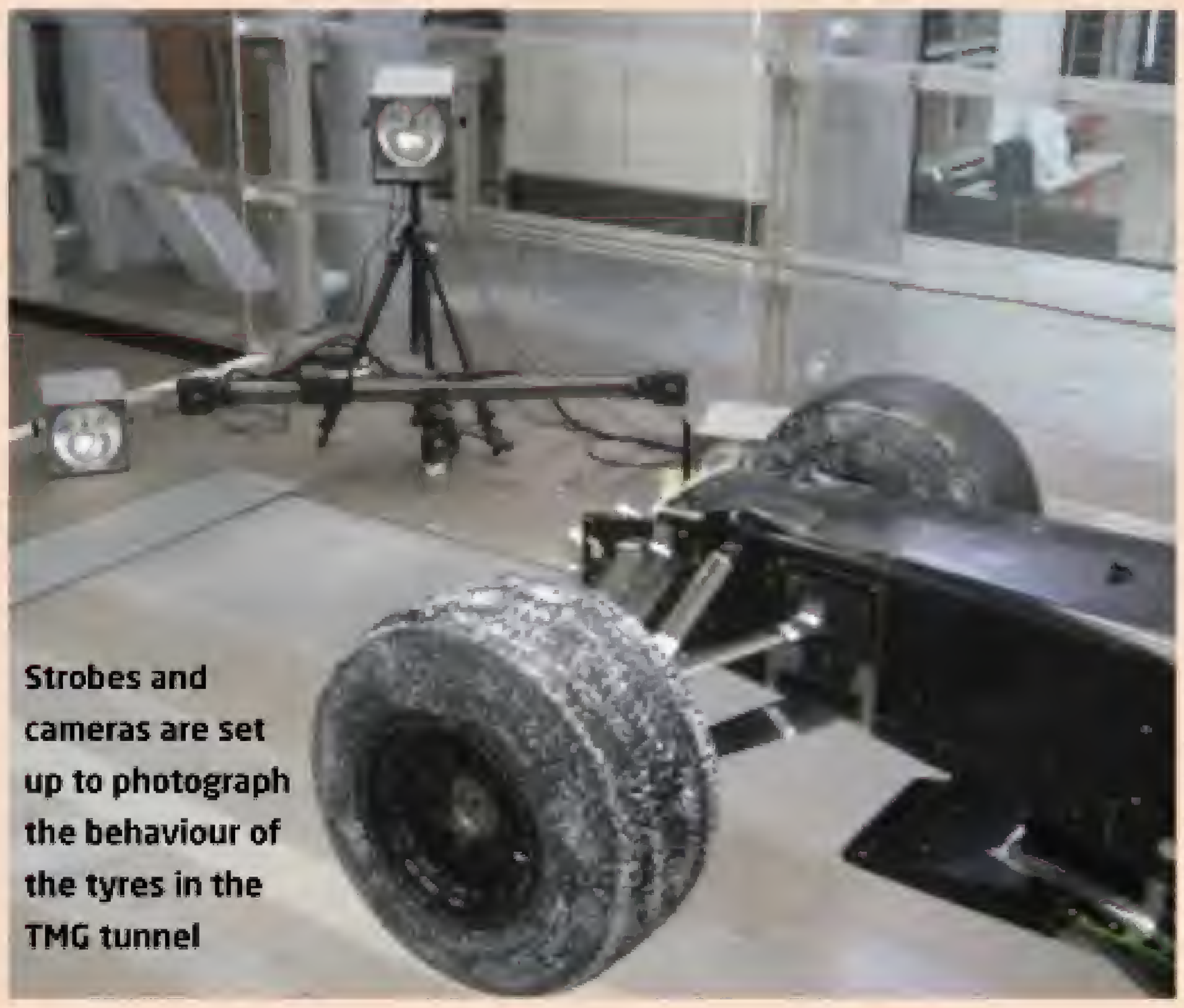
Toyota pulled out of Formula 1 before Pirelli provided the control tyre, but it was on the verge of a huge technical breakthrough with its wind tunnel tyres when the plug was pulled at the end of the 2009 season.

The TMG facility in Cologne is still used by many of the current Formula 1 teams, and its wind tunnel is considered to be one of the finest and most advanced in the world.

'We run pretty low tyre pressures, and then apply a force through the pushrod from an internal actuation system within the model to provide a pre-load,' says TMG's head of aerodynamics, Chris Hebert.

'We have a stainless steel belt with a system underneath measuring the vertical contact patch forces, allowing us to preload the tyre up to 30kg in the vertical direction. If you have a cloth belt, it is still possible to apply some kind of pre-load, but you are in danger of wearing the belt out very quickly.

'The other way of pre-loading without actuators is to passively make the wheel assembly very heavy. If you are aiming for 30kg of pre-load, you can make a rim and upright assembly that weighs that same amount.



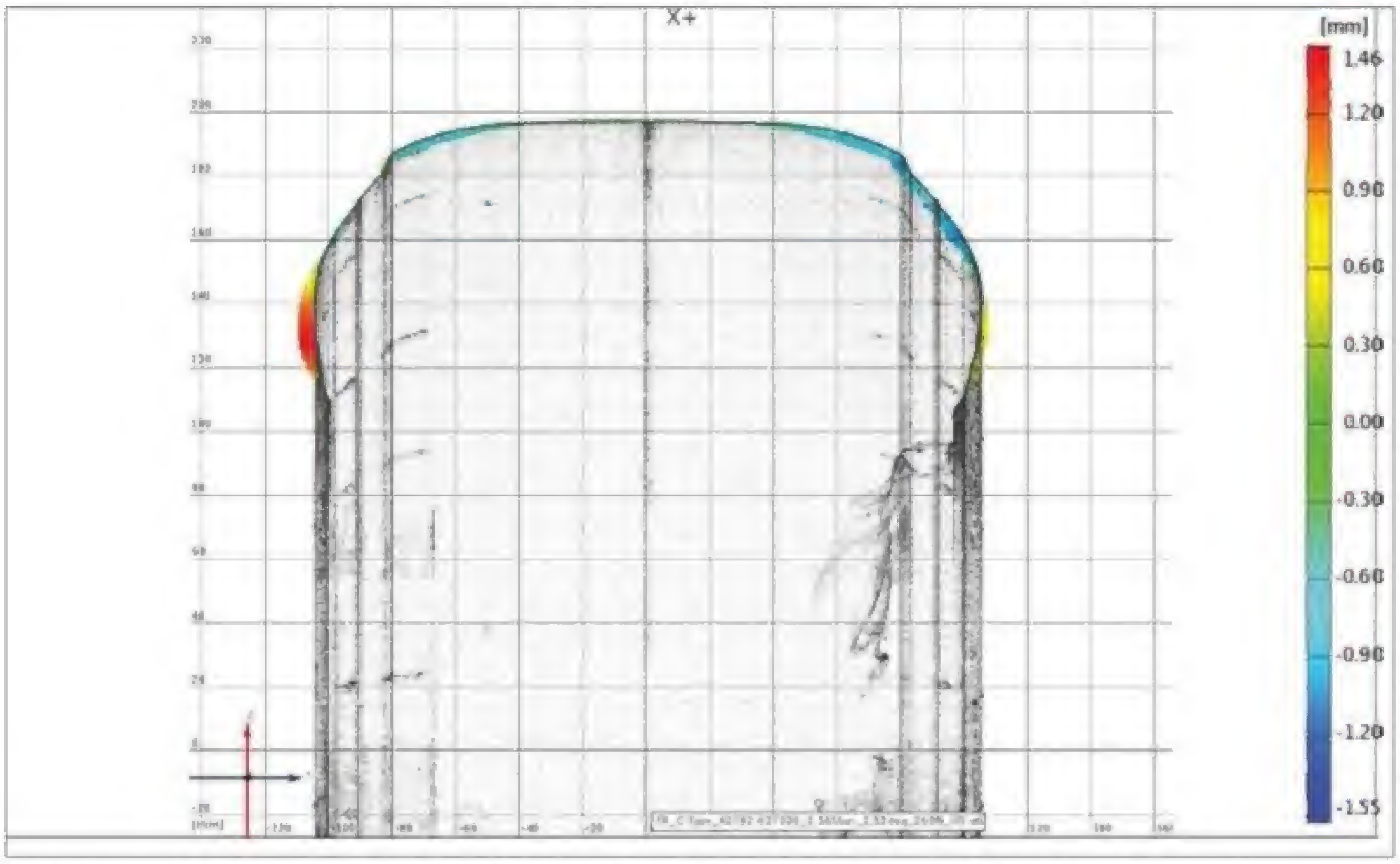
Strobes and cameras are set up to photograph the behaviour of the tyres in the TMG tunnel

TOYOTA MOTORSPORT GMBH

The advantage of the pushrod system is that you are not fixed to one specific pre-load. You can pre-load up to 30kg in our wind tunnel, but you can also reduce the pre-load to reduce the tyre squash.

'If you want to simulate what happens on corner entry – for example in F1 you are always seeing them lock up the inside wheel because the tyre is very unloaded – in the wind tunnel, you would have maximum pre-load on the outside tyre and minimum pre-load on the inside tyre.'

Wind tunnel measurements are hard to get right. A scale model has to replicate what happens on track, and with tyres, that causes particular problems with deformation under extreme loads. TMG relies on stereoscopic cameras to provide 3D images of the tyre,



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Modulating the tyre squash in the tunnel allows for better alignment of suspension out in the real world

variable force going to tyres through the suspension systems – still modest, but capable of both pushing or pulling the wheels, and superimposed to the (constant) gravity force at each 'corner'. The result is that the loaded radius of each tyre changes under control. With some difficulties due to the associated instability, one can also simulate extreme conditions like almost unloaded tyres – just as it happens at the inner-front corner of the real car in peculiar corner-entry condition. Smoking tyre is not offered, however!

The ability of modulating the tyre squash allows to better align the movement of the suspension to the real world. This realism is as important as for the tyre-shape in isolation.

Wind tunnel tyres need to stay cool, whereas real tyres require the opposite. This is a consequence of low-grip/low-load coupling, and not more of 10-20degC above ambient temperature is normally registered. Surface tyre temperature is also a useful indirect measure to monitor how the tyres are behaving.

They would pass the great part of their life revolving at constant RPM, this being higher if compared to full-scale conditions. In fact, while the rotational speed of a tyre-replica is about 2400 and 3000 RPM for 50 per cent and 60 per cent scaled models respectively, the full-scale tyre continuously ranges between 1200 and 2500 RPM inside the 150-300kph speed-window, with very rapid and frequent variations (braking, above all). Also, at 'all the rest constant', the higher the RPM, the higher the wear: despite not being the most important aspect, it is one of those behind the preference for adopting the largest model-scale. Tunnel dimensions and budget permitting, obviously!

The structure of tunnel tyres has to answer to completely different requirements in comparison to their full-scale

The revolution came when F1 tyre manufacturers started to supply the first prototypes of inflated scaled-down replicas

and has found ingenious ways of creating the right deformation.

'We have an optical measurement system,' says Hebert. 'The tyre is sprayed up with a stochastic pattern. It is basically a spray pattern with graduations of different grey colours. The optical measurement system will take a photo of the tyre with cameras that are spaced apart by a metre, and the images, like your eyes, are very slightly different. Using the computer software, you identify a small pixel in the frame that is the same in both images. The computer then knows where that is, and starts to match that schotastic pattern in the left and right image, and can work out in 3D space where that tyre is.

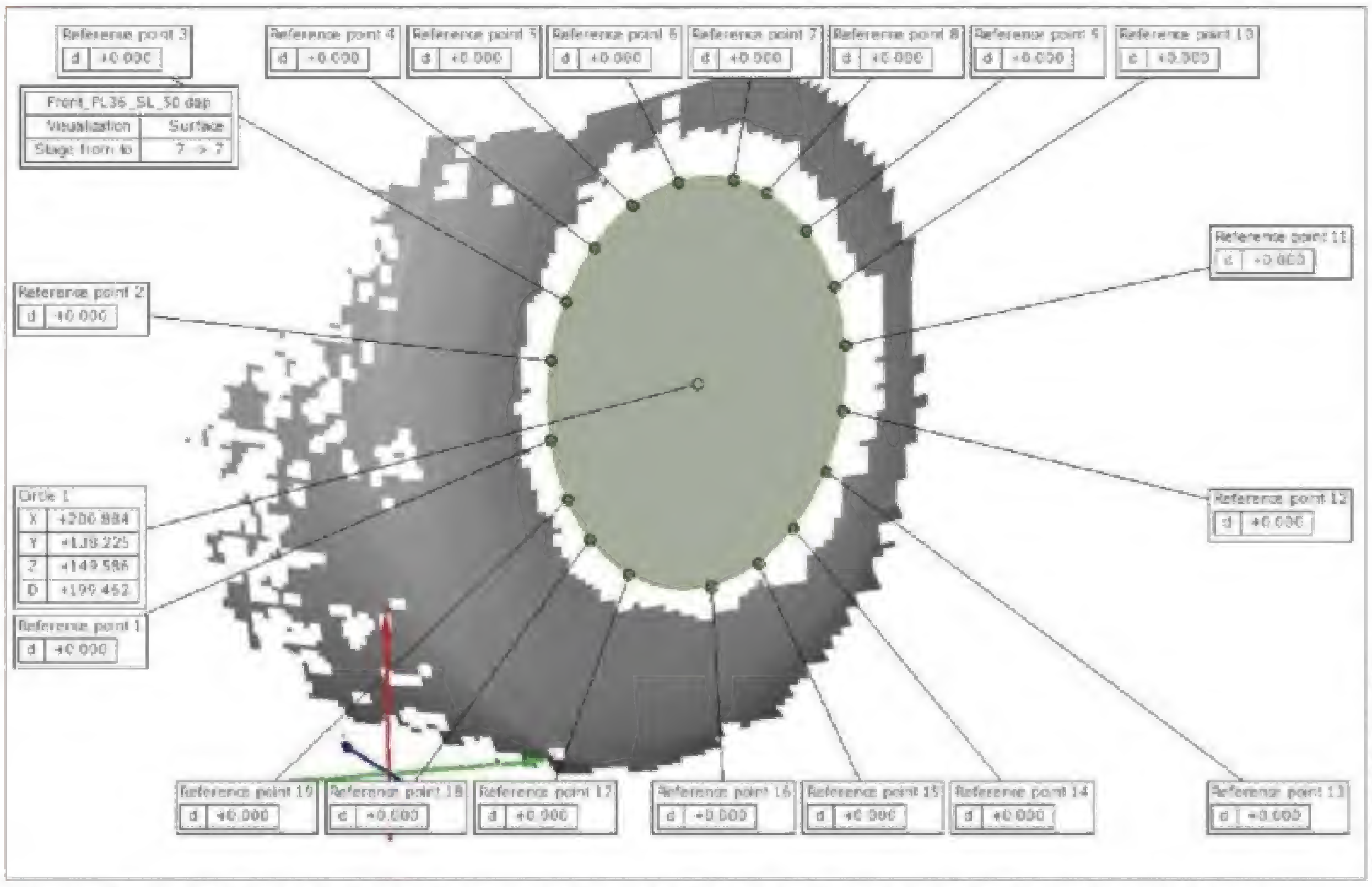
'It is basically a stereoscopic camera system that can provide surface information of the tyre. You then take those photos at different pre-load values, see the different deformation, and match that to the information you have from the tyre supplier, as they can provide you with FE models of their tyres to say what the deformation is under certain loading conditions.

'The further difficulty with replicating what happens on track is where there is a huge amount of movement laterally. If you mounted a camera on the floor at the rear you would see the tyre and the rim move massively. You think that the rim will be stiff but, as with the tyre, it too flexes under the cornering loads. Lateral movement is very difficult to simulate in the wind tunnel because we slip the tyre on the belt, as it cannot take very much lateral load at all. In the wind tunnel, we put silicone on our tyres to reduce the friction between the belt and the tyre, so it rolls perfectly well in a straight line; when we yaw and steer the car, the tyres continue to rotate with the belt, but they slip across it. There is no real lateral force. If you put too much lateral force into the belt it loses tracking, flies off and causes a lot of damage.

'We have designed and built a prototype system where we would have an internal actuator within the tyre that would allow us to deform the sidewalls laterally. The actuator is between that air gap between the rim and tyre. We did build one in the latter stages of our F1 involvement. There were issues with maintaining an airtight seal, and with that solution there were issues with temperatures as well. We managed to overcome some of those, but with Toyota's pull out from F1 we never progressed beyond prototype stage. If someone came to us and said they would like the system we would jump on it.'

The internal actuators only really work with the Formula 1 tyre, with the large sidewalls that are partly used for damping due to their stiff suspension. That feature also leaves room for actuators within the tyre, but for the LMP1 programme, which Toyota is running from the Cologne base, that's harder to replicate.

'With the size of the sidewall, the stiffness of the LMP tyre is much higher, and you would have very little depth of tyre to play with to allow you to get that big deformation,' says Hebert. 'You need enormous forces, and therefore big actuators and to package them in is much easier to do in an F1 tyre.'



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Results of tunnel analysis of a front tyre. Note the various points used to determine the shape for reference

equivalents. Weakness is required to permit deformation close to the ground under low loads, but at the same time the structure of shoulders, shoulders-tread transition and tread, all have to be carefully designed to counteract the centrifugal force that, at higher RPM, are not negligible at all. Incorrect design would cause abnormal dynamic shape by narrowing the shoulders and 'doming' the belt. Indeed, this is what happened with the initial prototypes.

Tunnel tyres should not show any significant alteration to wet surfaces with time. In the past, I was personally exposed to some experiments to measure the aero sensitivity to even small 'details' distributed on to the side of the tyre surface, and I had to admit that I was astonished about the level of aero-sensitivity we recorded. The roughness – that inevitably tends to change with the ageing of both tyre, running-belt and the nature of surface treatment – plays an important role too. For instance, incorrect levels of roughness would incorrectly locate the separation line of the surrounding flow (above all on the top part of the tread). For similar reasons, the aerodynamic measurement and development of an F1 car with used tyres (mid/end-of-stint conditions) is a considerable challenge.

The last thing that wind tunnel tyres need to offer is constant behaviour both during the single-set life and 'set-to-set', not to affect tunnel testing with repeatability issues – one of the biggest enemies to all experimental aerodynamicists! The initial warm-up has to be fast, maybe a few runs only, and the ageing phase should ideally proceed with negligible impact to the general mechanical behaviour. A quite distinctive end-of-life cliff has to be preferred to a progressive, continuous change of mechanical characteristics during the entire tyre life. By this, the great part of the tunnel run is carried out with the same tyre-set will be (almost) free of undesired tyre effects and, users also become more familiar with the right moment to move to a new set of tyres.

Mission accomplished, then? Only partially, I'm afraid. Despite all these huge technological achievements, there are a few fundamental aspects that still are not as wished. Above all, due to the low level of grip, rubber tyres are reluctant to offer lateral deformations at their bottom as the real tyre experience during cornering manoeuvres with high lateral G. Nowadays, this is still a serious challenge, and several highly complicated systems are adopted to reduce this gap of realism.

The potential depths you could go into regarding aero are almost limitless, but suffice to say the need to correctly replicate the tyre shape in dynamic conditions is absolutely enormous. Here are some of the reasons why...

At the front of the F1 car, the complex and large front wing system plays a strategic role, not only to generate load and balance the car, but to closely interact with the wake of the tyre in order to stabilise and properly 'move' it. This then puts the rest of the car in the best conditions to generate the most efficient downforce. Controlling the tyre wake for it to not interfere with the engine-cooling ducts is also vital. The devices you see under the front part of the chassis and on the sides of the so-called side-pods are also conceived to create proper flow-structures, finely tuned to interact with those of the tyre wake.

It's only in the last decade that aero in F1 has become so sensitive that tyre realism has become a seriously considered issue

At the rear, the flow features associated by the presence of the tyre, so close to the floor, have a great impact on the fundamental mechanisms governing the behaviour of the floor diffuser. Nowadays, the interaction with the exhaust gas plume flowing in the channel between tyre and floor is at the top of the list of key phenomena that need to be simulated with high precision.

For both front and rear tyres, the flow surrounding the contact patch is very peculiar and sensitive to even minute shape-changes. This is also due to the high velocity reached by the flow in these areas. The ground effect of the car is among the first mechanisms to be influenced by an incorrect representation. As well as this, the behaviour of brake ducts and all aero devices linked to the inner part of the wheels are heavily dependent on the tyre surface, due to their proximity to it.

Last but not least, the percentage contribution from the tyres to the total drag is quite high for an F1 car. And the lower the downforce setting, the higher it is. Development with the wrong tyre shape will adversely affect all the drag-related conclusions and – more importantly – one would risk being wrong while assessing the balance of the car and its variations.

So it's incredibly important to react as fast as possible to maintain the fidelity of the tunnel tyres to any shape-change – even of a few mm (normally neglected in the past) – directly or indirectly announced by the manufacturer. The level of the current competitiveness is such that, even before receiving official data of a new tyre spec, aero engineers are used to speculate on any future tyre shape by altering the control parameters of the scaled-down tyres at their disposal in order to record the most important 'what if?' as soon as possible.

And if that's not enough, there is another element to all this that needs to be added, down at a purely procedural and logistical level.

Scaled-down tyres are carefully tested and measured before going into the tunnel. This process is also useful to filter out possible 'bad' tyres. Once in the tunnel,

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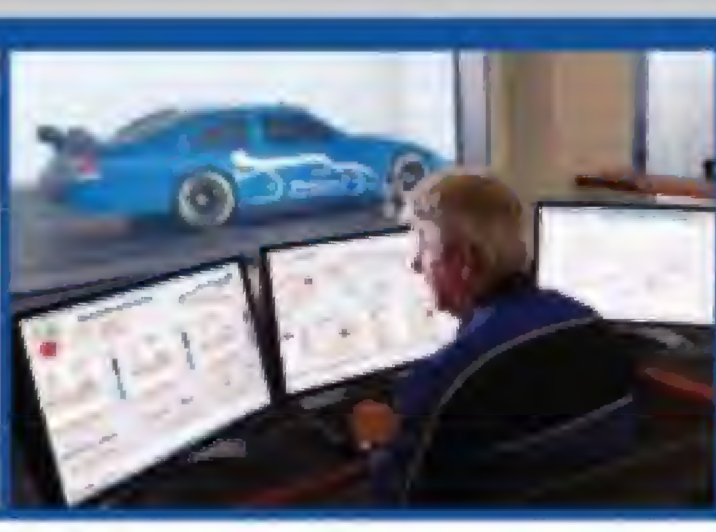
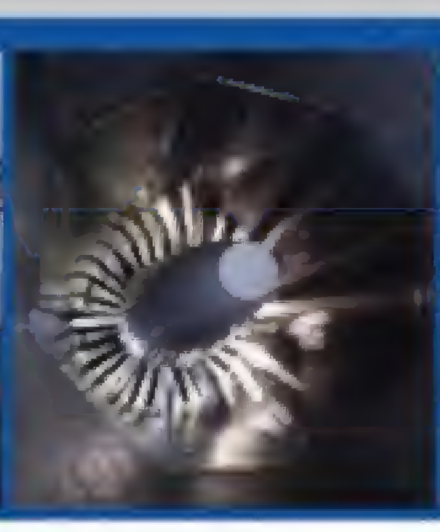


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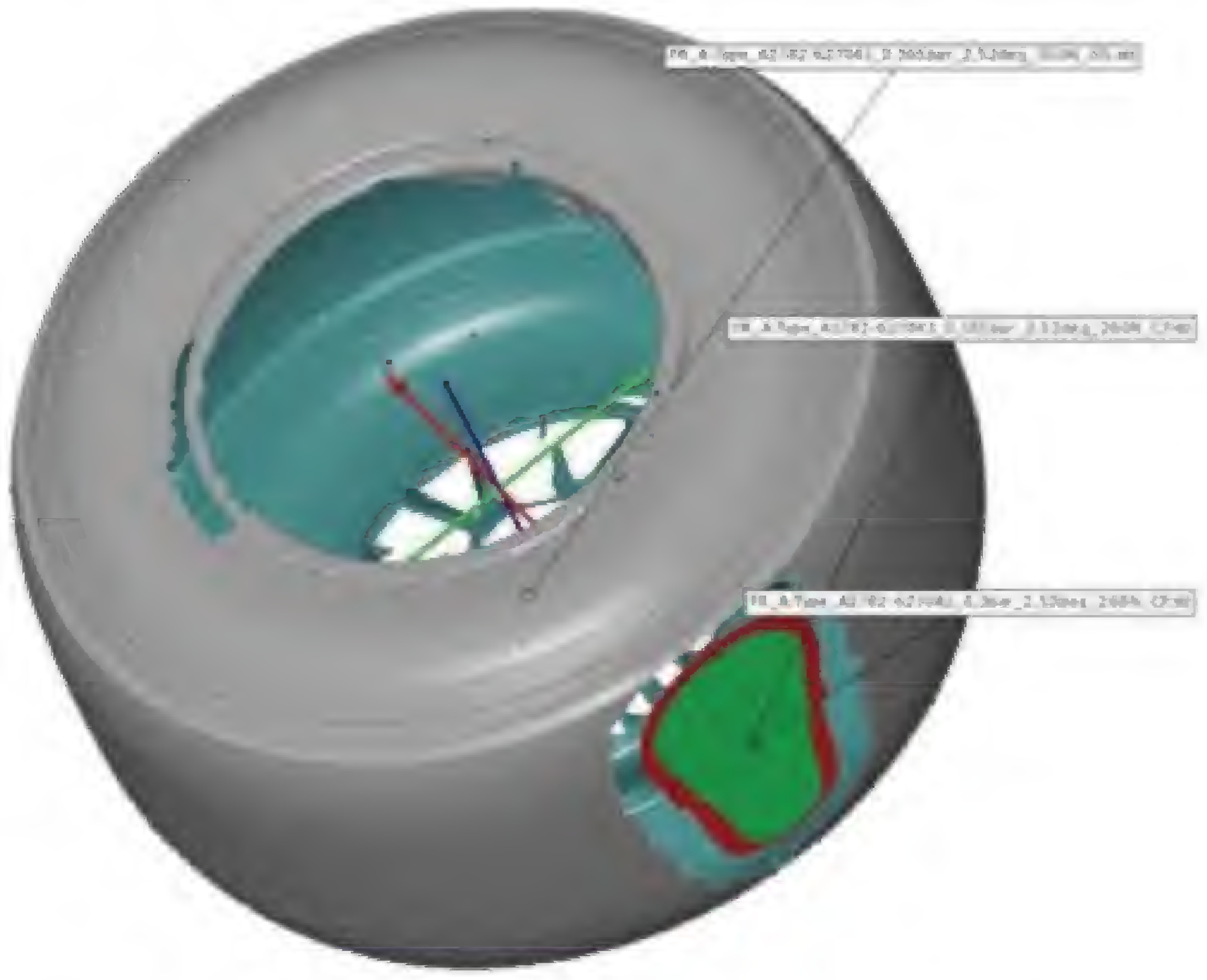
they are constantly monitored in terms of external profile, surface temperature, internal pressure, slip ratio, vertical deformation, unbalance-induced vibration, and so on. With all of these parameters available, engineers monitor the general behaviour and ensure that the deformation is under control and within the expected ranges.

As satellite accessories governing the process, it's important that I touch on the need to have a customised balancing machine. Undesired bouncing, even at a very small level, can adversely affect both the life of the tyre as well as the general quality of the aero testing. Another customised tool, easily overlooked, is the equipment devoted to install and remove tyres. Because of the size differences involved, off-the-shelf machines simply don't work.

Last, but certainly not least, shape database and statistical analysis tools are created to follow the tyre-spec evolutions and to know all about tyre behaviour and their life. This is because, as I said before, the number of tyre sets for tunnel testing is prescribed, and so the timing of installing a new tyre set has to be optimal.



All of these huge efforts are in place to be sure that the aerodynamic experiments – so complex and expensive – can direct the development correctly and efficiently. Time-wise, you really don't want much to be wrong. An incorrect tyre usage in the wind tunnel, when not spotted early during testing, will inevitably misdirect any development. Given the rapid pace of change involved in top level racing, the line between early and late can be extremely blurry!

Any problems relevant to the representation of tyres are inevitably extended to CFD environments too. Having the virtual tyres working in close alignment with tunnel and track is an absolute must, but it's much less simple and fast when compared to practical wind tunnel work. This is mainly because of the complexity behind setting up an F1-level CFD calculation, where ride changes, steering, roll and yaw effects are constantly analysed, as in the tunnel.

Developing with the wrong tyre shape will adversely affect all the drag-related conclusions

Other complications come through the numerical difficulties while dealing with high proximity areas such as the boundary of the contact patch and proximity with suspension arms and devices. Persisting too much with an obsolete tyre shape is equally risky. As support, complex tools like CAD parametric tyre modelling and automatic mesh deformation are constantly being developed to react as soon as possible.

Teams devote important resources to develop and acquire mechanical engineers, aerodynamicists, designers, electronics and model-makers in their aerodynamic dept that are experts in tyres – forming a sort of 'tyre team' to keep on top of this ever-evolving strategic matter. Teams that are better prepared to manage this sophisticated technology have a huge leg-up in terms of the potential to be successful in modern F1.

PIRELLI'S PAUL HEMBERY DISCUSSES WIND TUNNEL TYRES

'Wind tunnel tyres are 50 or 60 per cent scale size, but internally they are not at all the same structure. They run at very low pressures, and the concept is to make them deform under load in the same manner as the full size tyre.

It is one of the more difficult jobs in Formula 1 because, not only do you have to do it on one wind tunnel, you have to do it on six or seven different ones, and they all have operating characteristics that are different. It is not a case of having one wind tunnel tyre, give it to the teams and let them get on with it. You have to modify them to work with an individual wind tunnel.

DEFORMATION

It is basically a measurement of form and deformation, so we see the deformation of the full size load and try to recreate the load at scale. We run them on a drum and you have a laser profile measurement, and you compare the two.

The difficult bit is to get the tyre to deform under load and the different surfaces between the different wind tunnels. Today, the flow of air over particularly the rear tyre is vital, and the closer we can get the deformation of the rear tyre, the better job it is for the teams.

The focus is now on next year, and [at the end of September] we have to supply next year's wind tunnel tyres.

TIME LAPSE

The time making the tyres is not the problem, it is making sure that you replicate the full size tyre. You get them, test them, send them to the team, get the loop back from the team with their data and feedback. That can be a long loop.

There might be one or two teams that can share the product, and each have access to the products, as long as you have one tyre. If someone thinks that you have done something better for one team, they can all order it – they can all have each other's tyre but they choose which one. We have three versions at the moment.

LATERAL LOADS

You create a carpet, a load carpet and different deformations at load. You also look at majority load, so there are going to be some conditions that are exceptional circumstances.

You try to create something that will work across the full range, but there are certain extremities where it is not possible.

The wind tunnel tyre itself is run with a very hard, durable compound because you don't want it to wear and consume. You wouldn't be able to drive on it, it is a hard compound to allow you do a lot of kilometres. They run at almost nothing in terms of pressure, very low, perhaps 1psi, just to get the deformation at load.'

Pirelli motorsport director Paul Hembery

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New power generation

The long-awaited new Formula 1 engine rulebook – marking the first major changes in over six years – looks set to provide a huge shot in the arm for top-level racing

BY SAM COLLINS


The 2014 Mercedes F1 V6 hybrid turbo

Grand prix racing is finally coming in from the cold. For many years the specification of Formula 1 engines has been frozen, and aside from some minor details, a 2007 2.4-litre V8 engine is much the same as a 2013 2.4-litre V8 engine.

In an attempt to control costs, the FIA decided that it would, in essence, ban engine development. All engines had to be homologated and modifications were strictly policed. The engine builders could only find performance gains from the peripheral parts like the exhaust and the lubricants – the specifications of the internal components, head and block were frozen.

But in 2014 Formula 1 is facing its biggest shake-up in years, with a new rulebook being introduced. Focused on innovative new hybrid powertrains, the regulations give a much wider range of technical freedoms, not least because the new 1.6-litre V6 engines are turbocharged.

While the concept of the power units was first discussed in these pages way back in 2007 (*RCEV17 N5*) and brought up-to-date in recent months (see *V22 N12* and *V23 N8*), one thing that has only just become clear is the level of development that will be allowed on these new power units. Many people believe that because all of the engines used in F1 are 2.4-litre V8s and have a frozen spec that they are all the same, but that simply isn't.

This is something that Rob White, deputy managing director (technical) of RenaultSport F1 is at pains to point out. 'People assume because the current engines are fixed that they are essentially all the same,' he says. 'But if you put the four engines currently racing alongside each other and take them apart, they are not the same. They don't behave the same in the car and there is nothing in the current regulations to say that they should do. It is wrong to assume that because each engine is of relatively stable spec that four engines have similar spec.'

Indeed, for example it is known from both driver and engineer feedback that the Renault had more flexibility in terms of mapping and it allowed teams to run a lot hotter with water and oil compared to the Cosworth CA.

For 2014, a return to fully open development was deemed to be an unrealistic option, which would essentially turn into an arms race judged on the power of the chequebook, but a degree of technical development would still be required. So how best to curb the seemingly inevitable battle of the bank balances, while still allowing at least some engineering creativity?

The solution that the FIA has decided upon is very interesting indeed. It uses a system of development points, or tokens, to restrict the amount of development allowed, but not the areas of development. At the end of February 2014, the engine manufacturers wanting to take part in that year's series will have to supply a complete power unit and a homologation dossier to the FIA.

'After you supply that dossier and the power unit, the spec is fixed and the bottom line is that there can be no change to the spec without the prior approval of the FIA,' says White. 'But that does not mean that the specification is locked in for the entire homologation period, which run up to 2020.

'There is this list of changes that are allowed annually and so there is a table of engine functions [see right] and what is proposed is that there is a limited amount of change permitted each year. The table divides the power unit into functional blocks, and we are not allowed to change every functional block for the purposes of performance or fuel consumption development each year. But we may modify a subset of them, and the size of the subset of the power unit that may be changed year-on-year reduces as time goes on.

'It becomes quite structured in the development programmes in future years. Everyone is very conscious of the sheer scope of the technology in these new power units, and therefore it is a

"Everyone is very conscious of the sheer scope of the technology in these new power units"

2014 TECHNICAL REGULATIONS: ANNUAL F1 POWER UNIT HOMOLOGATION TABLE

Function	Function details	Weight	For 2015	For 2016	For 2017	For 2018	For 2019 + 2020
Upper/lower crankcase	Cylinder bore spacing, deck height, bank stagger	2					
Upper/lower crankcase	All dimensions including cylinder bore position relative to legality volume, water core	3					
Cylinder head	Except modifications linked to subsequent modifications	2					
Combustion	All parts of parts defining combustion. Included: ports, piston crown, combustion chamber, valves geometry, timing, lift, injector nozzle, coils, spark plug. Excluded: valves position	3					
Valves axis position	Includes angle but excludes axial displacement	2					
Valves drive	From valve to camshaft lobe. Position and geometry. Exhaust and inlet. Including valve return function inside the head	2					
Valve drive - camshafts	From camshaft lobe to gear train. Geometry except lift profile. Includes damping systems linked to camshaft. Exhaust and inlet	1					
Valve drive	Gear train down to crankshaft gear included. Position and geometry. Includes dampers	2					
Covers	Covers closing the areas in contact with engine oil cam covers, cam-timing covers	1					
Crankshaft	Crank throw, main bearing journal diameter, rod bearing journal diameter	2					
Crankshaft	Except crank throw, main bearing journal diameter, rod bearing journal diameter. Includes crankshaft bearings	2					
Con rods	Including small and big end bearings	2					
Pistons	Including bearings and pin. Excluding crown	2					
Air valve system	Including compressor, air pressure regulation devices	1					
Ancillaries drive	From ancillary to power source. Includes position of the ancillaries as far as drive is concerned	3					
Oil pressure pumps	Including filter. Excluding internal if no impact on body	1					
Oil scavenge systems	Any scavenging system	1					
Oil recuperation	Oil/air separator, oil tank, catch tank	1					
Engine water pumps	Include power unit mounted water pipes	1					
Injection system	PU mounted fuel system components (eg high pressure fuel hose, fuel rail, fuel injectors, accumulators). Excluding injector nozzle	2					
Inlet system	Plenum and associated actuators. Excluding pressure charging, trumpets and throttle associated parts and actuators	1					
Inlet system	Trumpets and associated parts and actuators	1					
Inlet system	Throttles and associated parts and actuators	1					
Pressure charging	From compressor inlet to compressor outlet	2					
Pressure charging	From turbine inlet to turbine outlet	2					
Pressure charging	From engine exhaust flanges to turbine inlet	1					
Pressure charging	External actuators linked to pressure charging	1					
Electrical system	Engine-mounted electrical components (eg wiring loom within legality volume, sensors, alternator). Excluding actuators, ignition coils and spark plugs	1					
Ignition system	Ignition coils, driver box	1					
Lubrication	All parts in which circulates oil under pressure (oil pump gears, channels, piping, jets) and not mentioned elsewhere in the table	1					
Friction coatings		1					
Sliding or rotating seals		1					
MGU-H	Complete. All internals including bearings, casing	2					
MGU-H	Position, transmission	2					
MGU-H	Power electronics	1					
MGU-K	Complete. All internals including bearings, casing	2					
MGU-K	Position, transmission	2					
MGU-K	Power electronics	1					
ERS	Wiring loom	1					
ES	Cells (article 5.4.3)	2					
ES	BMS	2					
ERS - cooling/lubrication	Cooling/lubrication systems (including ES jackets, pipes, pumps, actuators)	1					

	For 2015	For 2016	For 2017	For 2018	For 2019	For 2020
Total of weighted items	66	66	66	66	66	66
Total of weighted modifiable items	61	51	51	43	3	3
Quota of total weighted items allowed for modifications	32	25	20	15	3	3
% of modifications allowed vs. complete weighted PU	48	38	30	23	5	5
Total of frozen items	5	15	15	23	63	63
% PU being frozen	8	23	23	35	95	95

Renault's 2014 engine, first revealed in June

case of trying to seek a balance between the unreasonable and in many ways undesirable solution, which would have to be a completely fixed spec right from the beginning. It would be incredibly difficult to imagine fixing the spec of something that is not yet mature, but equally we are all conscious that it is not sustainable to have parallel programmes developing whole new engines, turbos, electrical systems every year. That can get out of hand.'

In simple terms, engine manufacturers are allowed to introduce a number of upgrades for the power unit each year. Every subsystem has been given a weighting between 1 and 3, and the engine manufacturers are allowed a specific number of points to modify each season.

So at the start of the 2015 season, the total weighting of all the modifiable components added together equals 61 points. As an example, the combustion area of the power unit including the ports, piston crown, combustion chamber, valve geometry, timing, lift, injector nozzle, coils and sparking plug is worth three points, while the pistons alone (excluding the crown) are worth two points and the cam covers one point.

POINTS OF INTEREST

The engine manufacturers are only allowed to modify components which add up to 32 points at the start of 2015. That reduces down to 25 points in 2016, 20 in 2017 and 15 in 2018. In line with that reduction in points, the amount of areas of the power unit that can be modified reduces too. In 2015, 48 per cent of the power unit is available for upgrade, but by the 2019 season that will drop to just 5 per cent. In reality this means that at the end of the 2014 season everything but the cylinder bore spacing, deck height, bank stagger, crank throw, main bearing journal diameter, rod bearing journal diameter, and the air valve system is open to change. But by 2019 the only things that can be changed will be the pressure charging system from engine exhaust flanges to the turbine inlet, and the engine's electrical system.

This means that the engine manufacturers are rather like an impoverished student in the supermarket trying to do their weekly shop - they want more than they can possibly spend. 'You have to choose what development work you deploy in the race engines,' says White. 'Obviously there are different ways to skin a cat. You can decide to do all the development work anyway and decide to deploy the things that pay off most, or you can try to be a bit cuter and allocate resources to things that are more promising and try to extract more performance from the things that you work on.

"The game will become working out which areas of development will be the ones to provide you the best return on investment"

'In real-life you will do a bit of both - you will do some overbooking in the development activity on the grounds that some things will fall by the wayside. There will always be more ideas than you can afford in the modification budget, so the game will become working out which are the ones that give the best return on investment. It is a way of limiting the quantity of development and therefore the resources necessary, and reducing the opportunity to just blitz the thing with money and create a new arms race.'

This will all create a fascinating situation, especially going into the 2015, 2016, 2017 and 2018 seasons, as engine manufacturers try to develop the power units. 'They are not yet mature designs, and with the best will in the world, you won't get everything done that you would like to or think that you should,' says White. 'This is going to oblige us to make some pretty hard choices. There will be some changes where there are a couple of options, both jockeying for position in the list for the last or first development token - there we have to decide which ones make the cut. We might all think that we need a new battery every year. If having a new battery every year is an important development item, then the points associated with batteries will be burned every year, and the rest of the development programme will be compromised accordingly.'

As time passes toward 2018, the amount of frozen components increases, and in this period engine development people will feel their scope is somewhat limited. But that freeze between 2018 and 2020 serves a purpose. 'The principle is that two years before the end of the rules cycle, we arrive in a situation analogous to the V8 where the spec is fully frozen,' says White. 'The thinking there is that during the two-year period, the engineering resources can be applied to the creation of the development of the following family of engines.'

What that future family of engines will bring is not clear, but one thing is certain - it will be very, very different to what we see in Formula 1 today.


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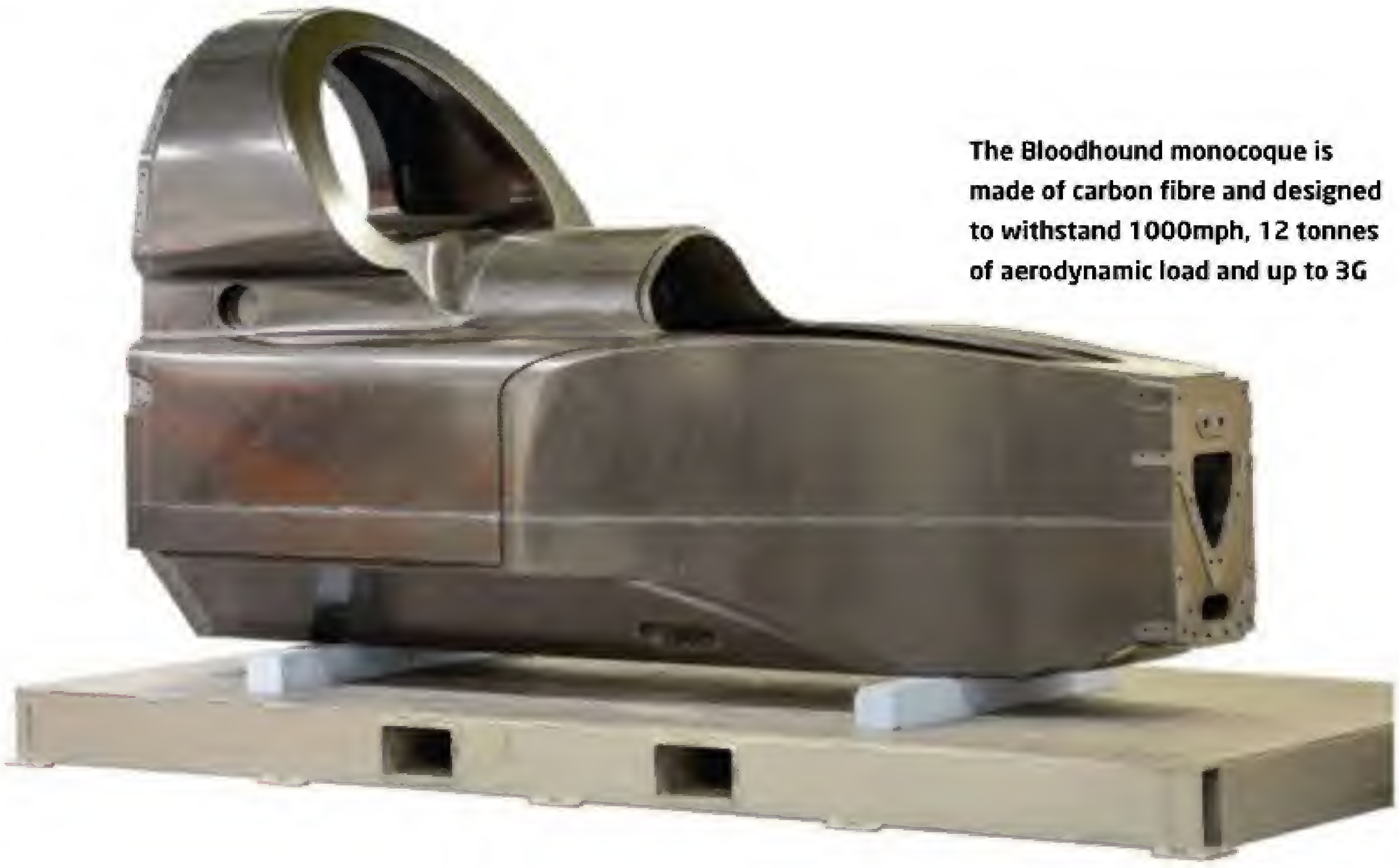
The cost of carbon

Composite materials have made for lighter, faster and safer racecars. But do high prices mean a new composite contender could be on the cards?

BY GEMMA HATTON



The Bloodhound monocoque is made of carbon fibre and designed to withstand 1000mph, 12 tonnes of aerodynamic load and up to 3G

Eighty per cent of an F1 car is composite, the majority being carbon fibre. With the price tag of an F1 carbon fibre monocoque standing at around £400,000, the sheer cost of the material may be its downfall.

Carbon fibre made its racecar debut in the late-60s as reinforcing strands bonded to glass fibre body panels. The early-70s saw carbon fibre in similar applications in F1, but it was only in 1981 that it was first used as a structural material for McLaren and Lotus. Since that time, it has been an integral part of all forms of motor racing and has served to make cars lighter, stiffer and safer.

It is often thought that the properties of carbon fibre are highly advanced when compared to metal alloys, but at an approximate 1550MPa tensile strength compared to 1300MPa for steel, it appears that this is not true. Therefore, it is the lower density of carbon fibre which results in such high properties per unit weight (specific properties) that makes it so effective: 167Nm/kg specific strength for steel compared to 1006Nm/kg for HM carbon fibre. With only 2.7kg adding a tenth to a lap time, the importance of weight saving is considerable. So, due to the specific properties, carbon fibre can make components at similar strengths but for a fraction of the weight.

The ultimate example of the advances in carbon fibre can be found in the Bloodhound SSC monocoque safety cell (see p34), which URT Group are building. To hit their 1000mph target, the Bloodhound team requires 12 tonnes per square metre of aerodynamic load on the monocoque as well as 3G of deceleration loads.

After 1000 hours of work, the finished monocoque not only houses the cockpit and controls, but also carries a rocket oxidiser tank containing one tonne of hydrogen peroxide, the front suspension, steering sub-assembly and the jet engine. With a 20mm thick wall constructed from a seven-layer carbon outer skin with a foam core and a five layer carbon inner skin, it provides the strength in the centre of a car weighing seven-and-a-half tonnes including fuel, while remaining lightweight.

The drive for safer motorsport has contributed to the widespread use of carbon fibre. There are strict regulations and testing required for all types of motorsport, carbon fibre composites meet the criteria if prepared properly.

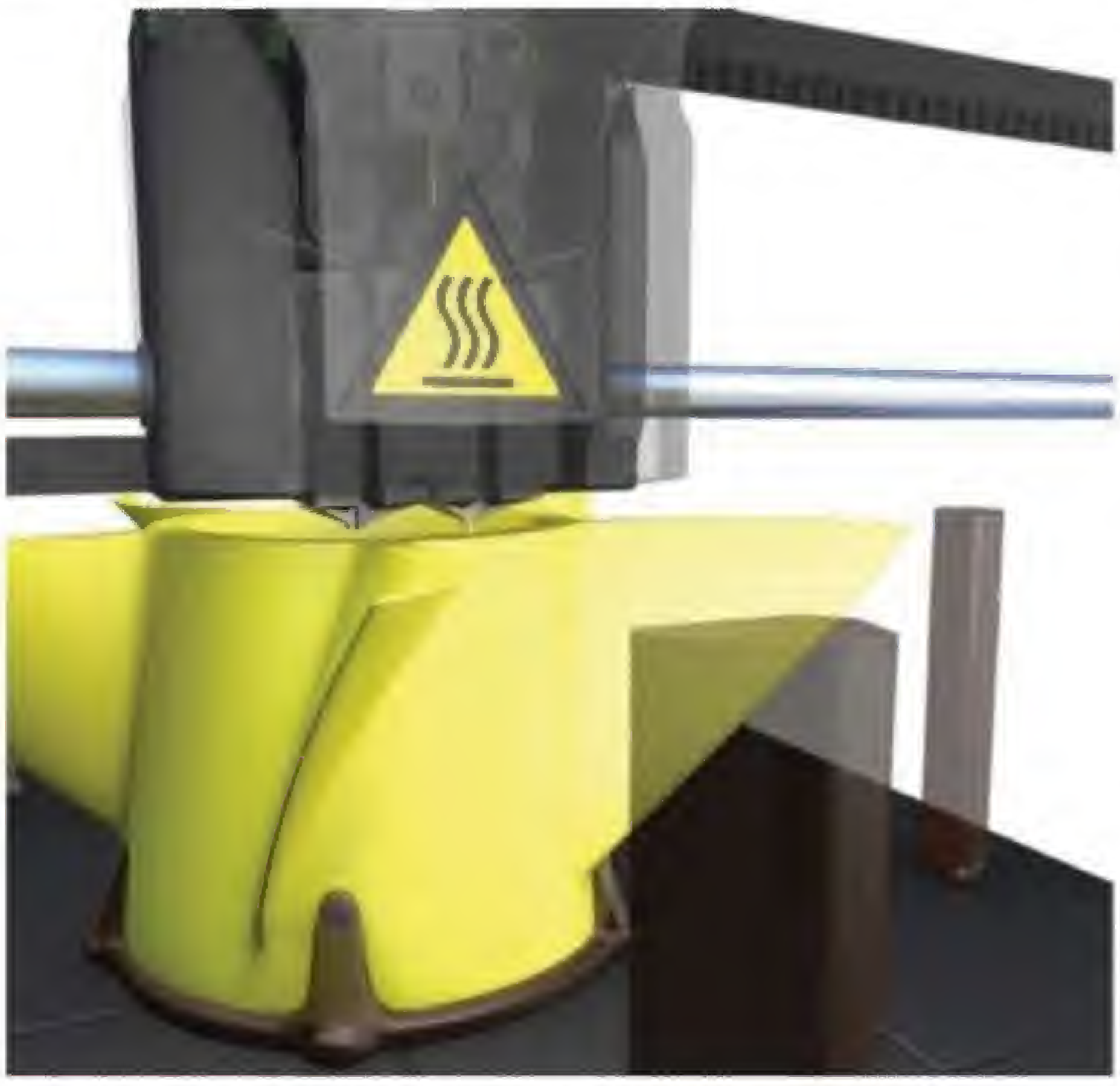
Aerodine Composites have developed an enclosed canopy system for Top Fuel dragsters. 'This is our most recent technological achievement,' says chief engineer Craig McCarthy. 'It was approved and introduced to the National Hot Rod Association a little over one year ago and is now used on several cars.

The polycarbonate windscreen and carbon fibre surrounding shroud here demonstrates another major benefit offered by carbon fibre materials: they provide the ultimate in protection

'The canopy has been a work-in-progress for a few years now. It was the brainchild of Don Schumacher Racing crew chief Mike Green, but we entered the project a couple of years ago to aid in the design engineering, manufacturing and NHRA certification process. We have since purchased the rights to the design so that we can manufacture the canopy system for any customer.' The goal of the project was to not only protect the driver from foreign objects and anti-intrusion, but to use lightweight materials without comprising structural integrity – a perfect case for composites.

The canopy utilises composites in two main parts: the windscreen and the surrounding shroud. 'The windscreen is thermoformed from Tuffak A polycarbonate sheet with a pre-formed thickness of 0.375 inches. Tuffak A is an industry-standard formulation of polycarbonate that is 300 times stronger than single-strength glass and is designed to not break, shatter or chip under high impact loading. After forming, the polycarbonate windscreen undergoes a hard-

URT Group manufactured the carbon fibre bodywork for Detroit Electric's pure electric SP:01, which weighs just 1090kg



How the printer head adds a layer of thermoplastic material for the fused deposition modelling process utilised by Stratasys

coating process that increases the chemical and scratch resistance.'

The surrounding shroud is composed of carbon fibre, ballistic grade S-2 fibreglass and high temperature epoxy resin. 'The general laminate schedule for this component consists of a 1 ply inner and outer skin of T-300 2x2 twill carbon fibre and three plies of 449 S-2 woven roving fibreglass in a quasi-isotropic layup, with material stiffness and strength the same in all directions,' says McCarthy. 'The laminate thickness of the shroud is 0.1 inches, and for further stiffness and protection, an aluminium honeycomb core was co-cured in the laminate directly above the rollcage area.'

Weight was a major initial concern. However, more drivers and teams are adapting to this concept. 'It's locked, sealed and delivered,' says Antron Brown, 2012 Top Fuel championship winner. 'After driving with it, it's definitely here to stay. You go from a 3/16th-inch piece of Plexiglas between you and 330 miles per hour to a fully enclosed cockpit that is bulletproof. Then you have all the struts to support your cockpit better. It gives a lot more support and we're happy we have it on our racecars now.'

The Bloodhound project is not the only work that URT have been up to as Matt Cox, founding director of URT explains. 'We were very excited to work with Detroit Electric, as we admire its vision and the engineering drive behind the company. The project allowed us to once again showcase our ability to produce high-quality bespoke composite components.' Detroit Electric showcased the SP:01 at the 2013 Shanghai Auto Show, and is the world's fastest pure electric sportscar. After five years of R&D, carbon fibre body panels were still on the agenda, reinforcing the hold carbon fibre has on the industry.

Sustainability is quickly becoming an essential selling point for any new production car or new season in a Championship. This sustainability concept has pushed both the automotive and motorsport industries into electric powertrains to reduce emissions and be seen as 'green'.

However, the use of carbon fibre in the automotive sector has taken decades, and is still only found on conceptual or high end models, simply down to the cost. Manufacturers are trying to slowly integrate carbon fibre into standard models by identifying parts with the highest potential value – such as the framework of the internal door – as carbon fibre can absorb six times more crash energy per pound than steel, and customers are willing to pay a premium for safety.

"In WRC, we could turn to glass fibre with thermoplastic fibres for use in high impact scenarios"

Gerard Winstanley, composites manager of Toyota Motorsport GmbH explains: 'We'd all like to think that what we do in motorsport affects what happens in road cars. As the whole industry is looking at lightweight alternatives, I am sure that we will be pushed in the direction where Toyota will want us to go. For example, how long can we keep carbon fibre in motorsport if it's just too expensive for the automotive industry?'

The composites department supplies internally to the World Endurance Championship, their impressive Toyota Hybrid concept, and a few road car projects. 'If we look into WRC, there would be other materials that we would need to analyse because there is a restriction on the amount of carbon fibre that you're allowed to use,' says Winstanley. 'In that case, we might turn to glass fibre with thermoplastic fibres that we would use in high impact scenarios such as the wheel arches.'

Carbon fibre will certainly remain in the motorsport industry for the time being, as its structural properties are just too effective to disregard. However, the high cost of the fibres itself as well as the manufacturing is simply making it too expensive for road cars even for its desired low weight, which is opening the doors for innovation within the composite world.

'I think we will be pushed in the direction of grown fibres such as hemp, or eco-friendly resin systems,' continues Winstanley. 'It will likely start off in bodywork, where there are little structural requirements, so carbon fibre will remain in crash areas. But I believe we will be forced to find a way to use these grown and biodegradable products more and more. There will be a point where the materials are either absorbed by the larger industries such as Boeing, or we are forced into another area to support the production vehicles.'

Matt Cox from URT agrees. 'Composites will be there, but will depend on rulings as to how far this goes,' he says. 'Cost capping is always on the agenda for premium motorsports. However, the technical boundaries need to be challenged as an industry that supports the automotive OEMs. This could come in the form of a shape-memory alloy (SMA) integrated into composite aero schemes, which could be activated to alter the cars performance dependant on a particular track section.

'This may sound a little out of reach, but similar technology has been researched and deployed in other sectors very successfully. There is a desire to use more composites in place of traditional metallic casings, and this could have a real impact for all sectors that are tasked with controlling emissions. Entry-to-medium level motorsport would also benefit from further composite development, making sure that all engineers have the ability to work with it personally.'

Two interesting areas of innovation are in nanocomposites and thermoplastics. It was suggested that Red Bull used some form of thermoplastic material

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James Bond's iconic Aston Martin DB5 at 1/3 scale was constructed from 18 3D printed parts manufactured by Voxeljet

It's ready! Illustration of the end of the FDM manufacturing process

in the floor at this year's German Grand Prix. With thermoplastic materials weakening at high temperatures, one thought was that Red Bull utilised this property by blowing hot exhaust gases on a section of the floor, which was guided by various aerodynamic devices to keep the flow laminar and attached to the surface. This would cause the thermoplastic material to weaken and bend down, creating a cavity for the exhaust gases. Such a cavity is against the regulations, which is why such a design would be so clever, because the cavity only opens up when exhaust gases are blown over it, and therefore when the car is running. Whether or not this is true, it presents a highly interesting concept.

A revolutionary technology involving thermoplastics is 3D printing. Who would have thought that in 2012, 3D printing would be advanced enough to 'print' James Bond's iconic 1960s Aston Martin DB5? OK so it was a 1:3 scale model, three of which were made by the partnership of Voxeljet's 3D printers and British Propshop Modelmakers to use in the making of Skyfall, but it demonstrates just how impressive this tech is, and could be in the future. As with the majority of 3D printing, thermoplastics were used to generate each of the 18 printed components layer by layer.

Another company that utilises thermoplastic materials is Stratasys, who supply 3D printing equipment and materials to generate physical objects from digital data. They are a world leader in 3D printing, and all their printers are based around the Fused Deposition Modelling (FDM) process, explains David Price, rapid manufacturing sales manager.

'For the FDM process, we're actually extruding a bead of thermoplastic material one layer at a time direct from CAD data,' he says. 'It's an additive process, rather than a subtractive one.' This thermoplastic material is composed of two types - one to make the part and one to support it. Alternating between the part material and the support material, each layer is deposited and slightly flattened by the extrusion head to instantly fuse the layers together. Each layer is made up of a series of flat ribbons that are 0.20-0.97mm wide and 0.13mm high - similar thickness to a human hair. This process offers high accuracy with tolerances as fine as 0.08mm, which is highly competitive with injection moulding processes.

As well as high quality prototype models, Stratasys also generate 'end use' parts. '98 per cent of the FDM manufacturing that we do for the motorsport sector uses the SR30 soluble cores to produce end use parts,' says Price. 'It is an acrylic-based thermoplastic and once placed in a hot water with sodium hydroxide solution, it dissolves, leaving the part material such as carbon fibre that was wrapped around the soluble core.'

The beauty of using soluble thermoplastics such as SR30 is that the process is completely automated, allows hands-free removal and there is no tooling required. 'Thermoplastics in this application provide more design freedom when compared to traditional CNC machining, as there are fewer design constraints because you are building straight from the CAD model.'

Joe Gibbs Racing - the second most valuable NASCAR team in the world - has utilised Stratasys 3D machines throughout their manufacturing processes. 'When milling these prototypes, we could have as many as seven machines set up, which was an inefficient use of our machines and manpower,' explains Mark Bringle, technical director of the team. 'With our FDM machine, we can start building new concepts 15 minutes after the CAD design is complete and prototypes are ready within a day. Previously, prototyping took a minimum of a week, and the delays became longer with inevitable design changes.'

After only a few months of prototyping, Joe Gibbs Racing cleared the backlog of new design concepts, many of which are now giving the seven race teams that vital competitive edge. 'From concept to car, that's the beauty of FDM,' says Bringle. 'It has permanently changed the way we do business. The drivers, the crew chiefs and the chief designers are all amazed at what we can do.'

It is clear that thermoplastics already making its mark on the industries. Whether it has the structural integrity to replace composites such as carbon fibre is yet to be seen, but there is no question that the composite world is evolving and evolving fast.

"I think we will be pushed in the direction of grown fibres such as hemp, or eco-friendly resin systems"

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Simulating KERS in sportscar prototypes

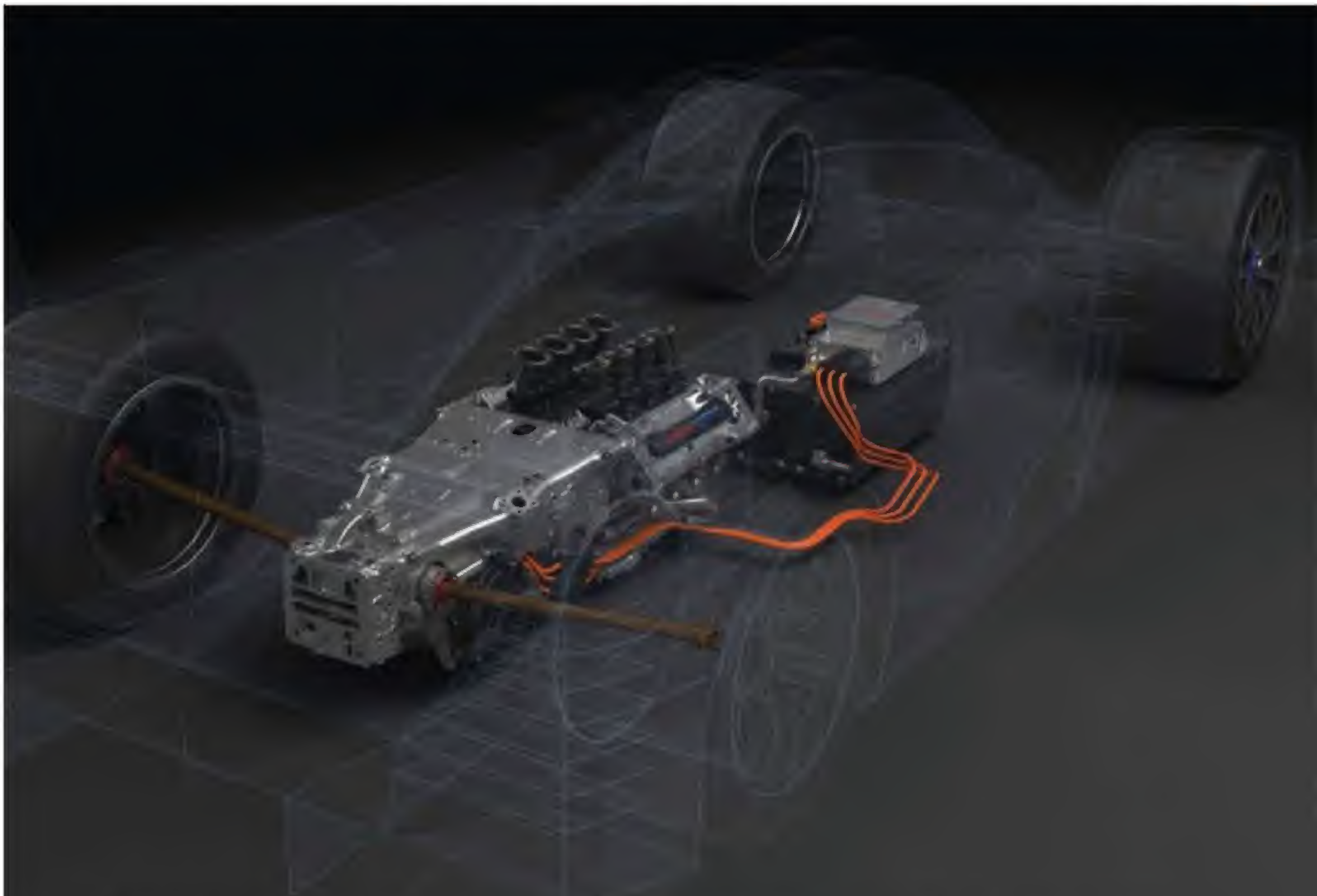
Where should KERS fit into your race strategy, and how is it best applied?

BY DANNY NOWLAN

One of the cool things about what I do is that from time to time I get asked to do some really exciting stuff in preparation for some big changes that are coming in the motorsport world. Recently I've been working with ORECA and doing some things with them in preparation for the 2014 World Endurance Championship. While I'm not at liberty to discuss exactly what we have been working on together, one of the things that it got me thinking about was KERS/hybrid systems.

Employed correctly, these systems have their place and can make a valuable contribution to the racecar. When they first started to make their appearance in 2008 I'll be the first to admit I was very sceptical about their true value. However, the work that I have done over the years has changed my view on this. The purpose of this article is to explore where KERS should fit in and how best to apply it. Although KERS is not permitted in LMP2 in 2013, we'll quantify this by running a simulation of at Le Mans with an LMP2-spec car.

Table 1 establishes the parameters for this discussion. Also, to keep things simple I'll assume a charge/discharge efficiency at 100 per cent. I'll be the first to admit this is unrealistic, but we are just exploring it to see if it is viable. The other thing we'll be doing is using the ChassisSim discharge mode, where it discharges the KERS on every straight. The energy it uses is weighted per straight, so energy isn't wasted in a chicane. We are doing this as a rough measure to evaluate multiple discharge points.



When KERS/hybrid systems first appeared in 2008, I was very sceptical about their true value. But I have changed my view on this

The first comparison to be made is when we apply a KERS system retrospectively to an existing LMP2 car. The results and specification of the car from the ChassisSim simulation is shown in **Table 2**.

As we can see, what we are dealing with here is a dead heat. However the speed overlay here is very revealing. This is shown in **Figure 1**.

So that we are clear, the coloured trace is without KERS and the black trace is our trace with the KERS added retrospectively. As we can see coming into the corner, the first trace – which is our speed trace – shows that we do pay for the extra weight. However,

Table 1: baseline Parameters for KERS calculation

Parameters	Value
Stored Energy	2000kJ
Charge rate	60kW
Discharge rate	60kW

Table 2: simulation comparison of Retrospective KERS

Car	Comment	Simulated Lap time
LMP2 no KERS	Baseline	3:35.41s
LMP2 with KERS	Added 50kg for KERS	3:35.47s

Table 3: simulation comparison of KERS added into the design

Car	Comment	Simulated Lap time
LMP2 no KERS	Baseline	3:35.41s
LMP2 with KERS	Same mass as baseline	3:33.78s

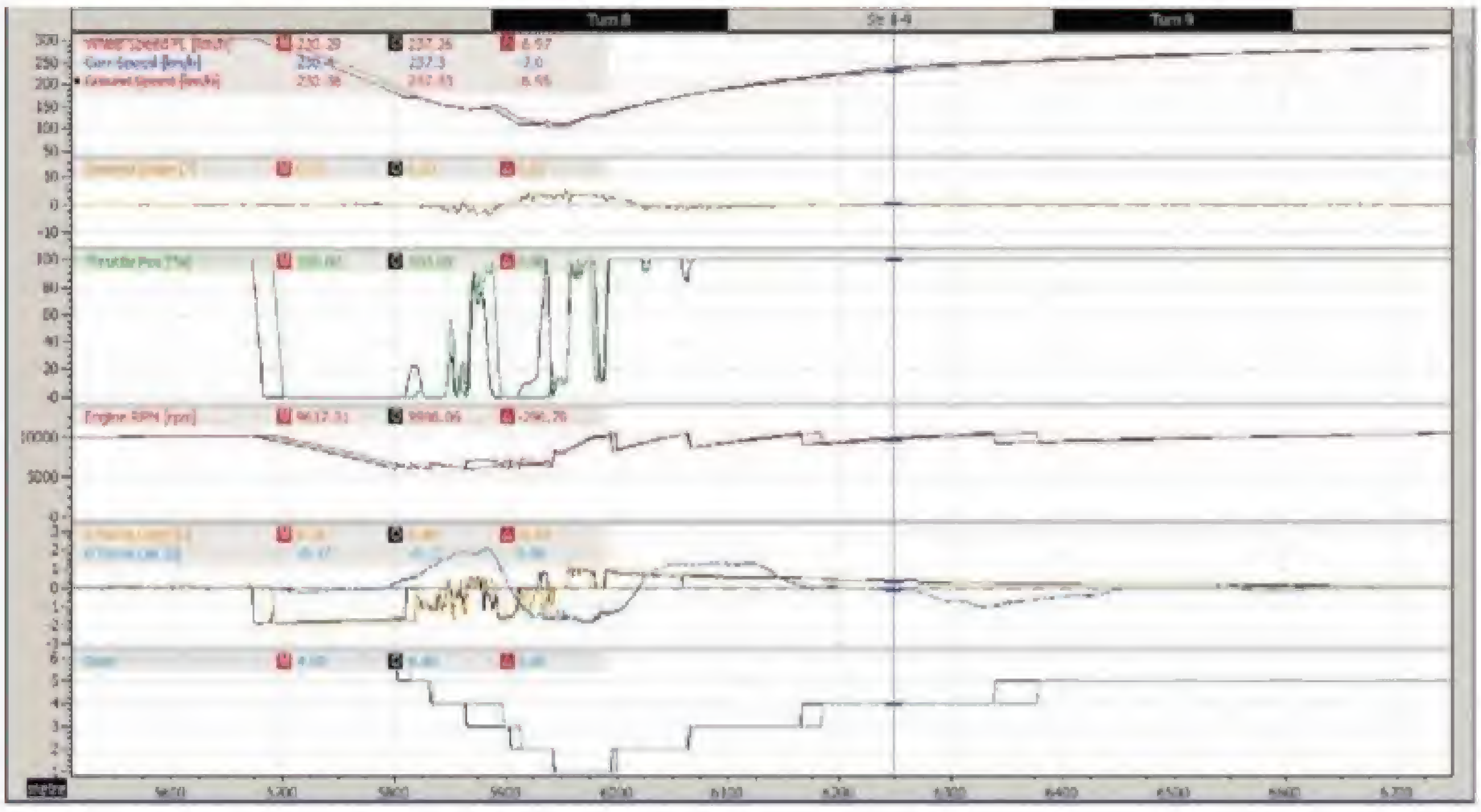


Figure 1: speed overlay coming out of a corner

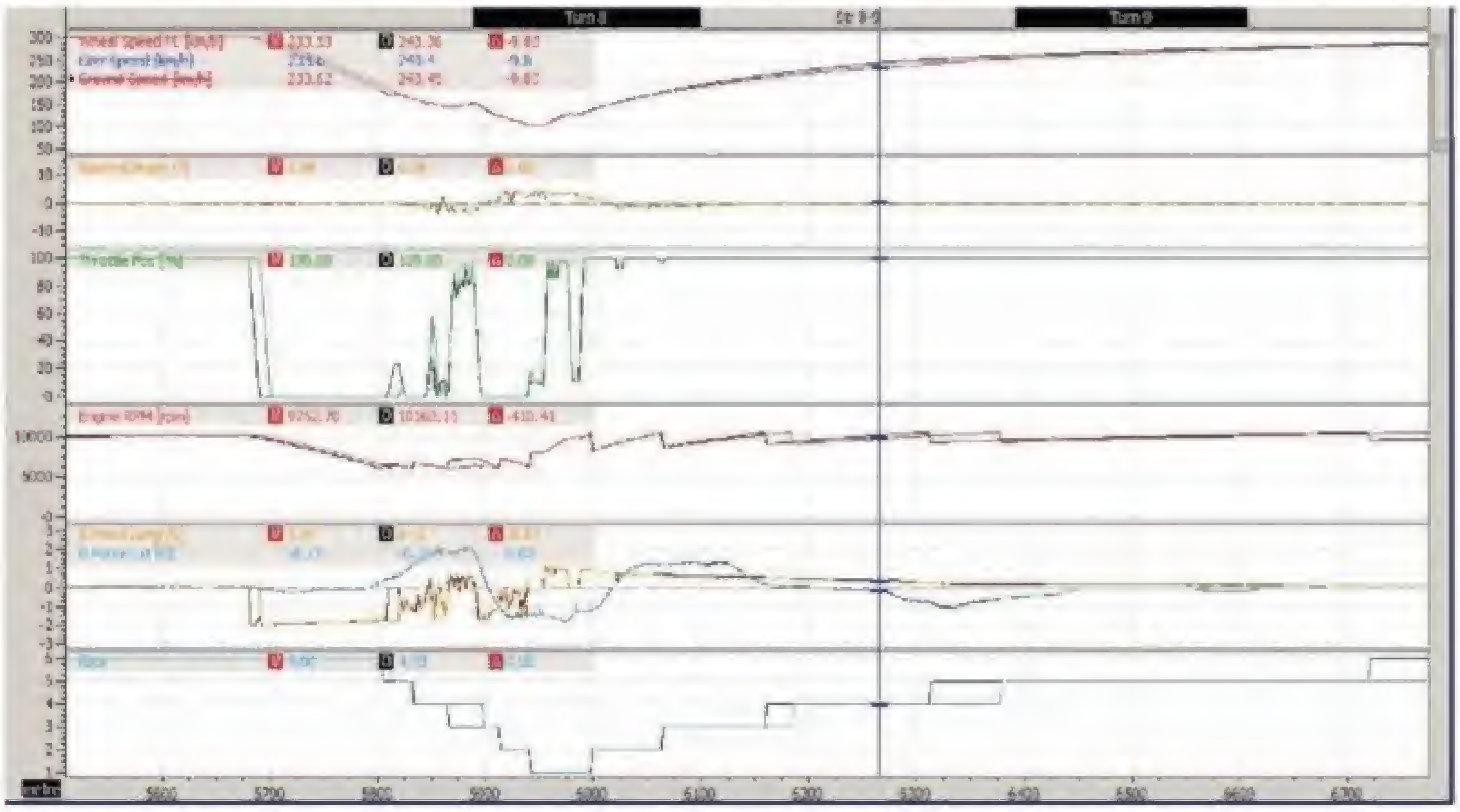


Figure 2: speed overlay coming out of a corner with KERS as part of the car design

coming out of the corner is where KERS really makes its presence felt. Coming out we get a speed advantage of 7km/h. This is not to be neglected, and if it was me I would be conducting further simulation studies to see if I could claw back some of that turn-in performance. As an example, if I was using batteries as my storage I'd see if I could shift them around.

KERS added retrospectively does show some promise and it is not to be sneezed at. However, at this stage it is not cause to get terribly overexcited about.

WEIGHTY THOUGHTS

The next step in this discussion is to consider whether the KERS/hybrid system has been designed into the car from the beginning. If it has been specifically designed into the car, we don't need to add extra weight. It's here that the systems really make their presence felt – the results are summarised in **Table 3**.

As we can see there, we are now dealing with a totally different animal. We are looking at an advantage of 1.6s and we haven't even played with optimising any of the KERS settings yet. At a place like Le Mans, this is the kind of potental gain that you ignore at your peril.

The comparison of the speed trace is very revealing. As before, the coloured trace is our baseline without KERS and the black trace is when KERS has been incorporated into the design of the LMP2 car. This is shown in **Figure 2**.

Things have changed a great deal from the state of affairs illustrated in **Figure 1**. Firstly, once we are actually in the corner the speed overlay is identical. It did brake slightly earlier, but this was just an anomaly for this particular corner. At the other corners, the brake markers were the same. However, once we are in the corner, the speed trace is the same. What this translates to is a 10km/h advantage once the KERS is applied on the straight. This is a significant gain that you would be certifiably insane not to take advantage of.

In an LMP2 car, coming out of the corner is where KERS really makes its presence felt. Here we get a speed advantage of 7km/h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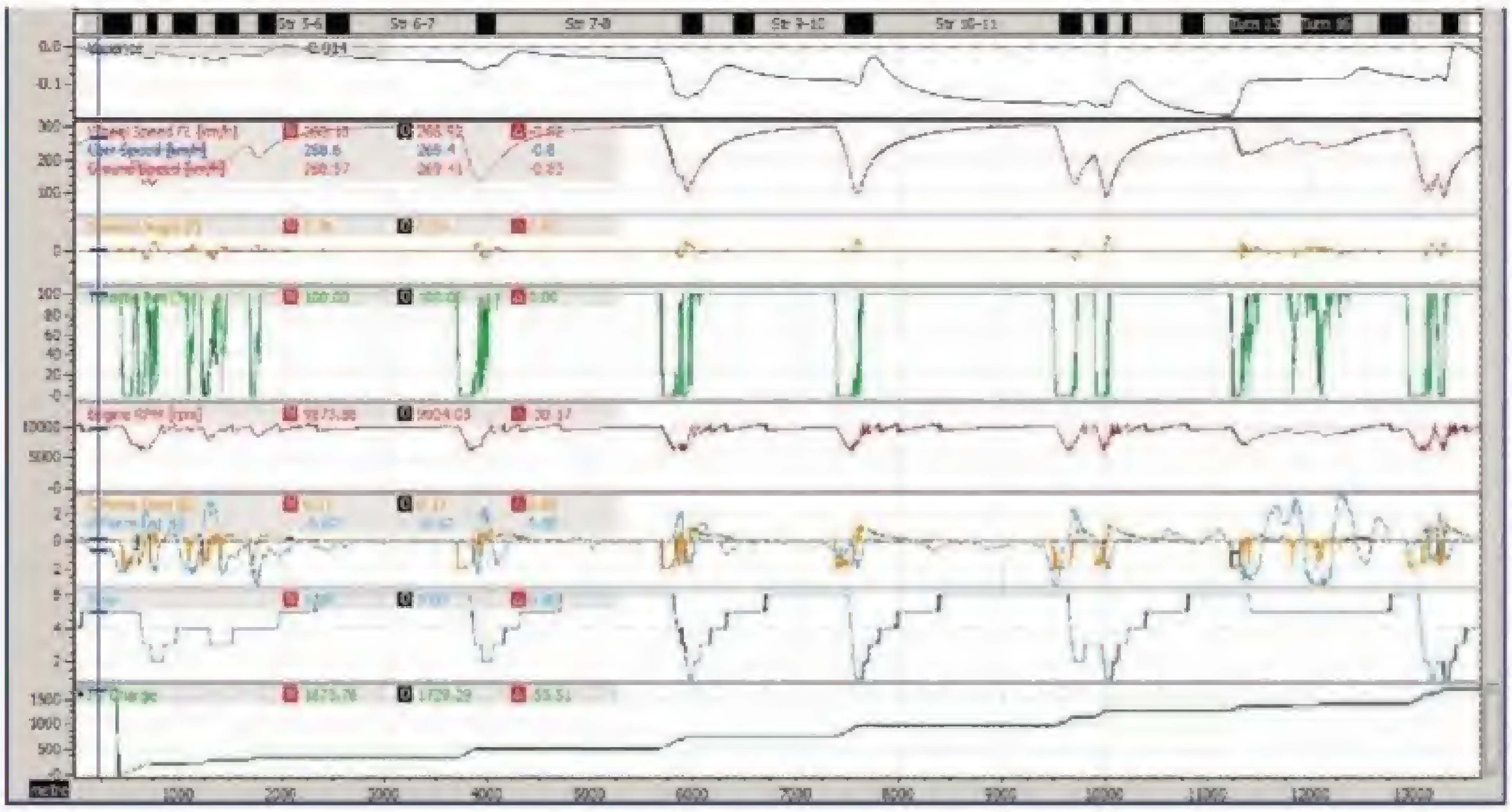


Figure 3: KERS/hybrid setup with 60 per cent brake bias vs 65 per cent brake bias

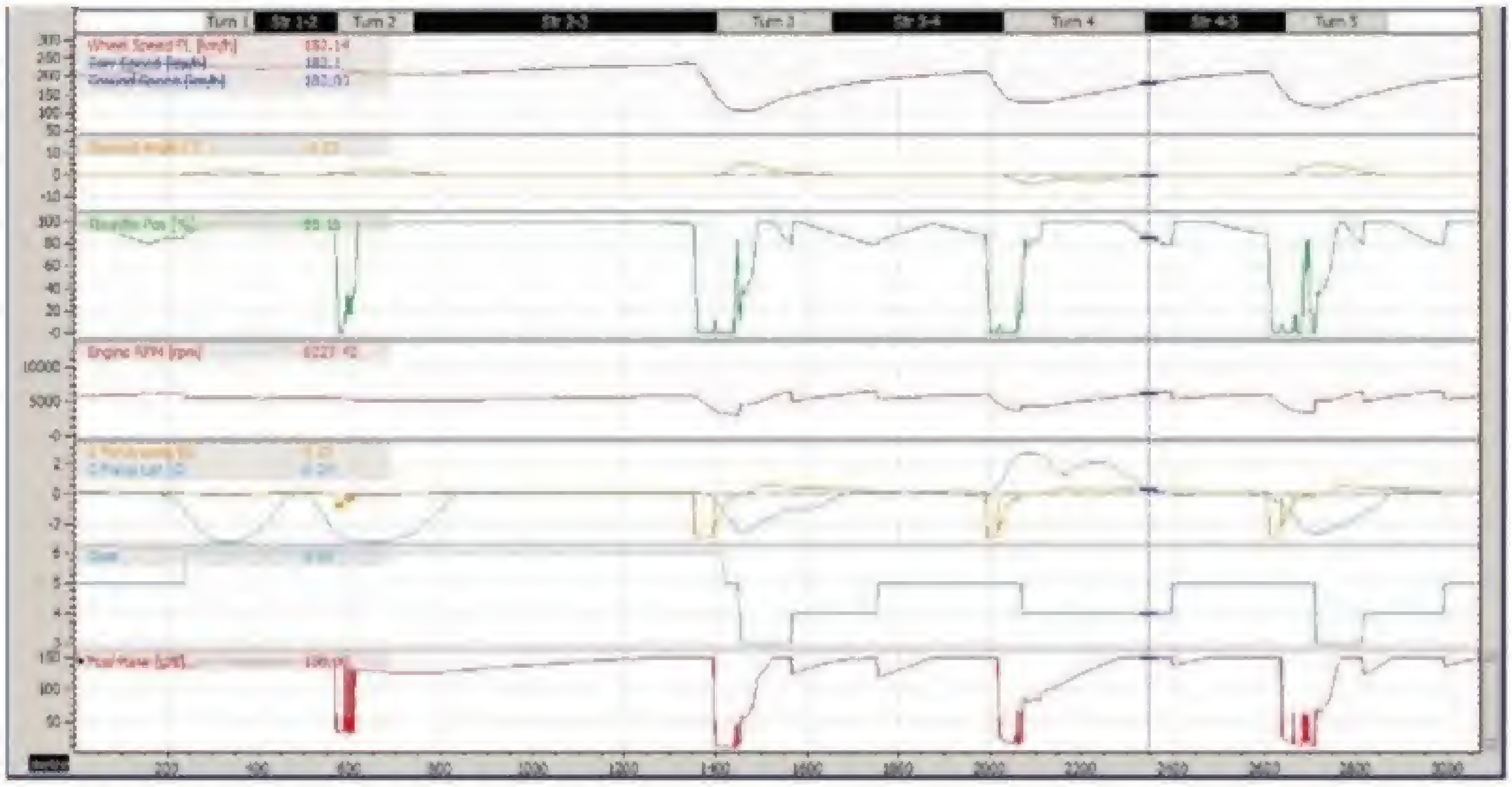


Figure 4: effect on enforcing a maximum fuel flow

However, we have not yet taken full advantage of what KERS/hybrid system has to offer. One of the key tenets about how KERS works is that during braking, whatever energy isn't being used by the rear tyres to brake the car is being used to put charge into the system so it can be discharged down the straight.

Consequently, to get the most out of KERS, you need to run more front brake bias so that you have leftover potential at the rear. To illustrate this, a simulation was run with the KERS system being run at a brake bias of 65 per cent as opposed to 60 per cent which was our standard. The results are shown in **Figure 3**.

Our standard setup with the 60 per cent brake bias is shown as the coloured trace and the 65 per cent brake bias setup is the black trace.

The two plots to pay attention to are the top curve, which is the compare time trace, and the bottom curve which shows the energy that you have harvested from the hybrid system.

Firstly, the last plot shows that with the revised brake bias we have managed to harvest 55kJ more energy. Used over 1 second, this forms an invaluable push to pass option for the driver. This also translated into what was going to be a faster lap. Right up to the Porsche curves, we were on track for a lap time that was going to be 0.188s quicker. Unfortunately we had a bit of a hiccup, but given the bumpy nature of this corner I'm not particularly surprised.

If I was race engineering this car I would refine this a bit more. Simulations will do this from time to time, so this is certainly not worth losing any sleep over. However, it does show very clearly that this is a setup change worth applying to the car. These changes also apply to the case where the KERS was added retrospectively as well.

EASY ON THE BRAKES

One thing to temper this discussion with is: don't overdo the front brake bias. Tools such as ChassisSim are absolutely ideal to pinpoint where the compromise points are. However, the last thing you want to do is to cook the front tyres so you can get a great boost going down the straight. That is just being a tad silly, and moving over from simulation into videogaming.

The other area where KERS will make its presence felt is in the fuel conservation regulations that are due to come into force for LeMans for 2014. One of the key regulations to bear in mind is a maximum fuel mass flow.

To illustrate the effect of this, let me show some early development work where I was enforcing a maximum fuel flow regulation. This can be seen in **Figure 4**.

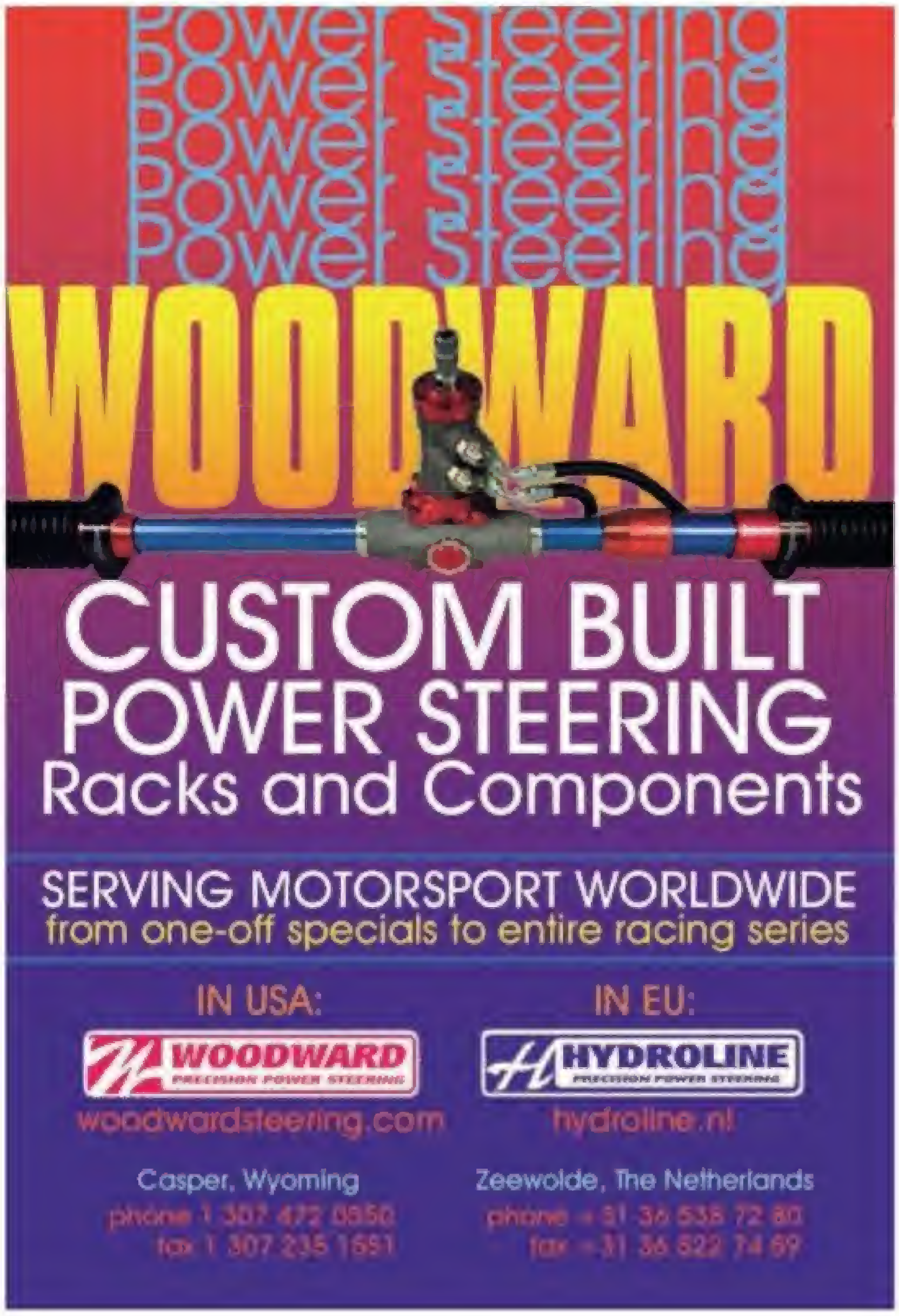
The two traces to pay attention to are the third trace and the bottom trace. The third trace shows throttle, while the last shows fuel mass flow rate. While this situation has been quite exaggerated, as we can see we have fixed a maximum mass fuel flow rate to 150g/s, and you can see the throttle dropping and the acceleration being degraded as it tries to deal with this.

Without something like a KERS/hybrid system, you are going to be in a significant disadvantage in this situation. If anything, you'll have to time the KERS activation when this throttle cut takes place. My personal view is that this maximum fuel flow regulation makes a hybrid system an absolute necessity.

Such systems have a necessary and valuable place for sportscar prototypes. As we deduced from our simulation work, while KERS/hybrid systems wasn't a night and day change when added retrospectively to an existing car, it was an open-and-shut case to a LMP2 class car with the KERS designed as part of the vehicle.

The initial advantage was 1.6secs a lap around Le Mans and with a bit of tuning this could be readily improved on. Also, the fuel conservation regulations for Le Mans in 2014 mean that such systems will increasingly justify serious consideration. Interesting times lie ahead.

To get the most out of the KERS system, you need to run more front brake bias so that you have leftover potential at the rear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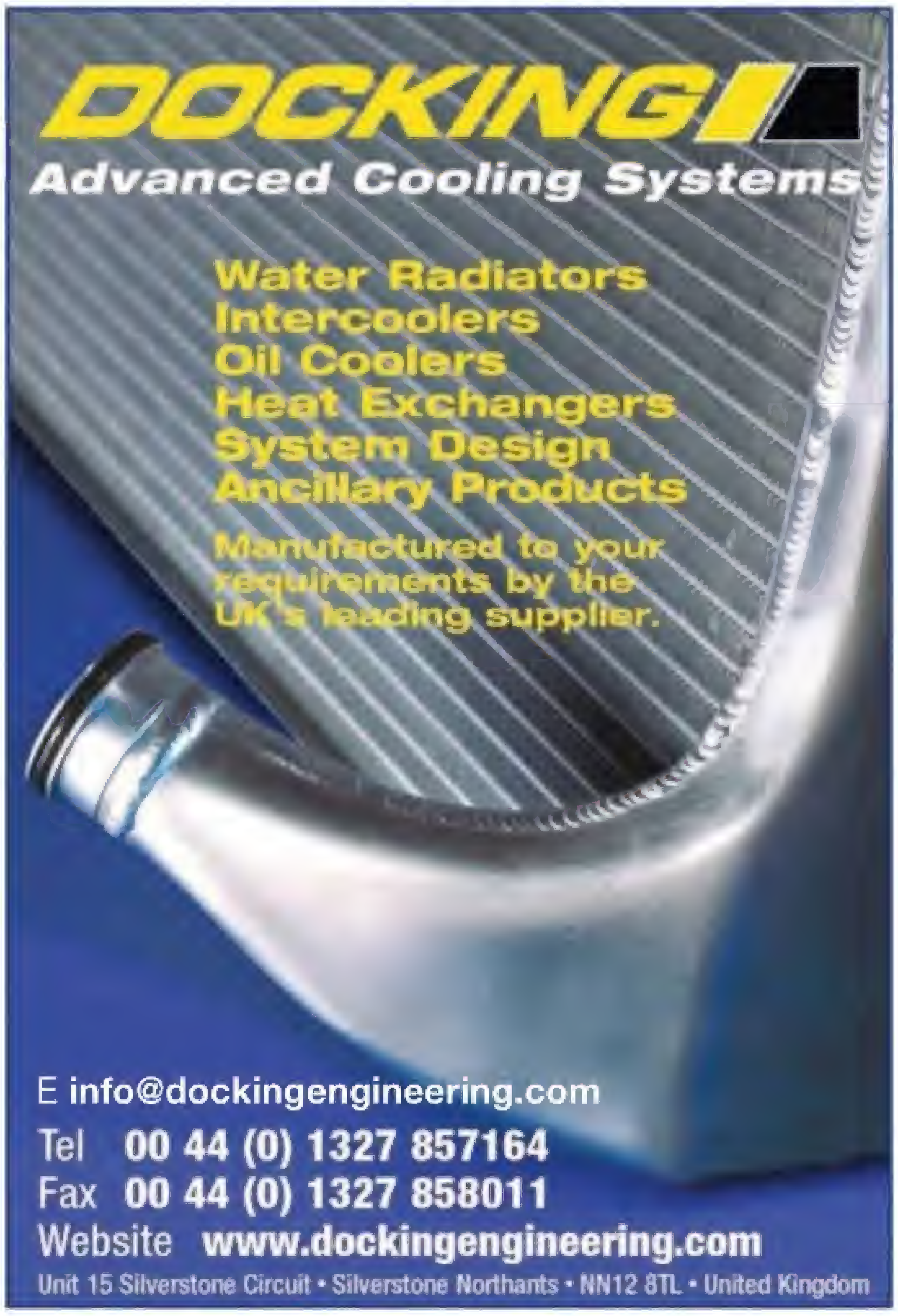

Toyota's new aero kit

At the fourth round of the World Endurance Championship in Sao Paolo, the Japanese manufacturer interestingly adopted a fresh downforce package

BY ANDREW COTTON

As the World Endurance Championship headed to Brazil, Toyota arrived in the country armed with a high downforce package which they plan to run through to the end of the season.

At the opening round at Silverstone the team ran two 2012 cars, and ran one alongside the new 2013 car at Spa that featured the Le Mans low downforce configuration in preparation for the 24 hour event.

With the remaining races at Shanghai, Fuji, Bahrain and Austin - circuits with similar downforce requirements - the manufacturer ditched the Le Mans package and produced a kit that included new front wheel arches, shallower angle headlights, new louvres front and rear, a new rear deck and new rear wing angle settings.

The decision to bring the high downforce package to Brazil seemed to be a strange choice, given the length of the straight from Turn 13 to Turn 1, a section that rises uphill and takes in parts of the old oval course, a place where overtaking is critically important in traffic. With Audi having produced a more powerful engine this season, switching to a more draggy setup seemed risky.

Yet while the package helped to deliver overall fast lap times, Toyota's motorsport director Pascal Vasselon explains that it is the super capacitors, an electrical hybrid system that is not susceptible to altitude, that helped to make the decision.

Taking the high downforce package to Brazil seemed a strange choice

'It is the same story as last year,' says Vasselon. 'We went from a Le Mans package to a sprint package because the next five races are in the same ballpark with the level of aero efficiency that we need; the levels of downforce and drag.

'The changes are obvious. The most obvious is at the front with the wheel arches, the diveplanes, the shroud that covers the splitters, the splitter itself, the rear engine cover and the wing, which has different settings. I will not give figures, but it is much

New, shallower angle headlights were among the raft of changes which the Toyota's downforce package took to the Six Hours of Sao Paolo

Also in the package were new front wheel arches, new louvres front and rear, a new rear deck, and a fresh set of rear wing angle settings

The remaining races in the series, taking in Shanghai, Fuji, Bahrain and Austin, all have fairly similar downforce requirements

After qualifying third in Brazil, Stephane Sarrazin crashed out of the race after just 34 minutes, while lapping a back marker

The firm's motorsport director Pascal Vasselon says the car's super capacitors' lack of susceptibility to altitude influenced the change

more downforce, and that's what we need for these kind of tracks.

'The usual problem in Sao Paulo is that you have two tracks in one, and you have to go for the best compromise. You have simulation techniques that tell you where to put the cursor, if you like. You have a long straight that tells you where to put the wing, but you have the middle sector, which is very demanding.

'Simulation techniques allow you to make the best compromise and target the level of downforce and drag. One thing worth considering and which is interesting is the hybrid system. We don't rely on top speed to pass cars – we rely on acceleration. Usually when you manage compromise between downforce and drag you always put a special weighting to top speed to pass in traffic. With a hybrid car, this weighting can drop a little because we pass cars at corner exit, and infield.

'We can go for a compromise between downforce and drag, compromising lap time and somehow disregarding the effect of top speed in traffic. Sometimes you have one setup for qualifying and one for the race. With a hybrid car it comes closer together and you can really target lap time and manage the traffic with the hybrid system.'

The package was expected to work well with the Michelin tyres. Both Audi and Toyota chose the 'high temperature' Le Mans tyre as their low-temp option for the rest of the season, and Michelin used another, high temperature tyre for the rest of the season following post-Le Mans testing.

Ultimately the TS030 didn't have the chance to show its potential against the Audi. After qualifying third, comfortably off the pace of the Audis, Stephane Sarrazin crashed out of the race after just 34 minutes while lapping a back marker.

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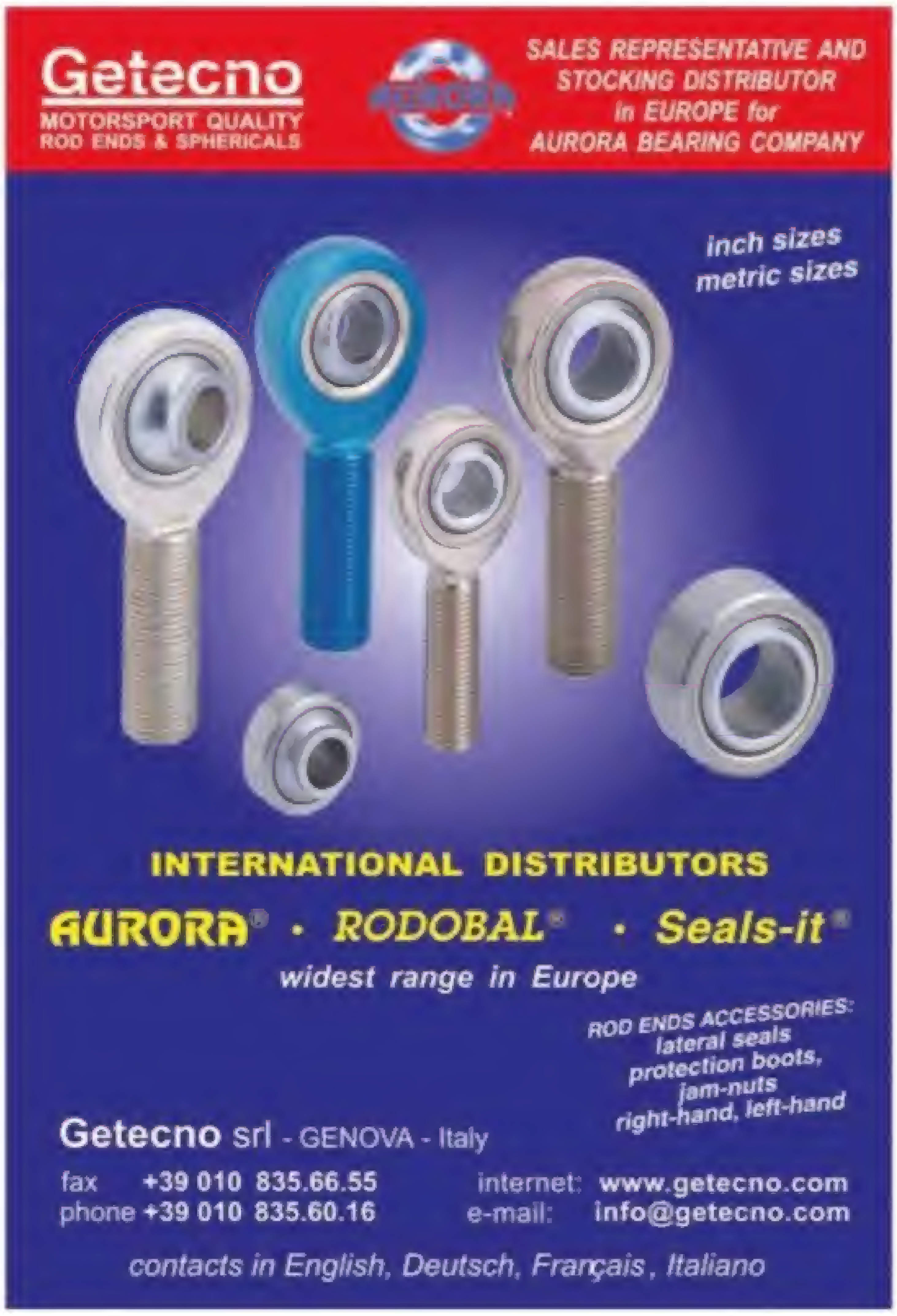

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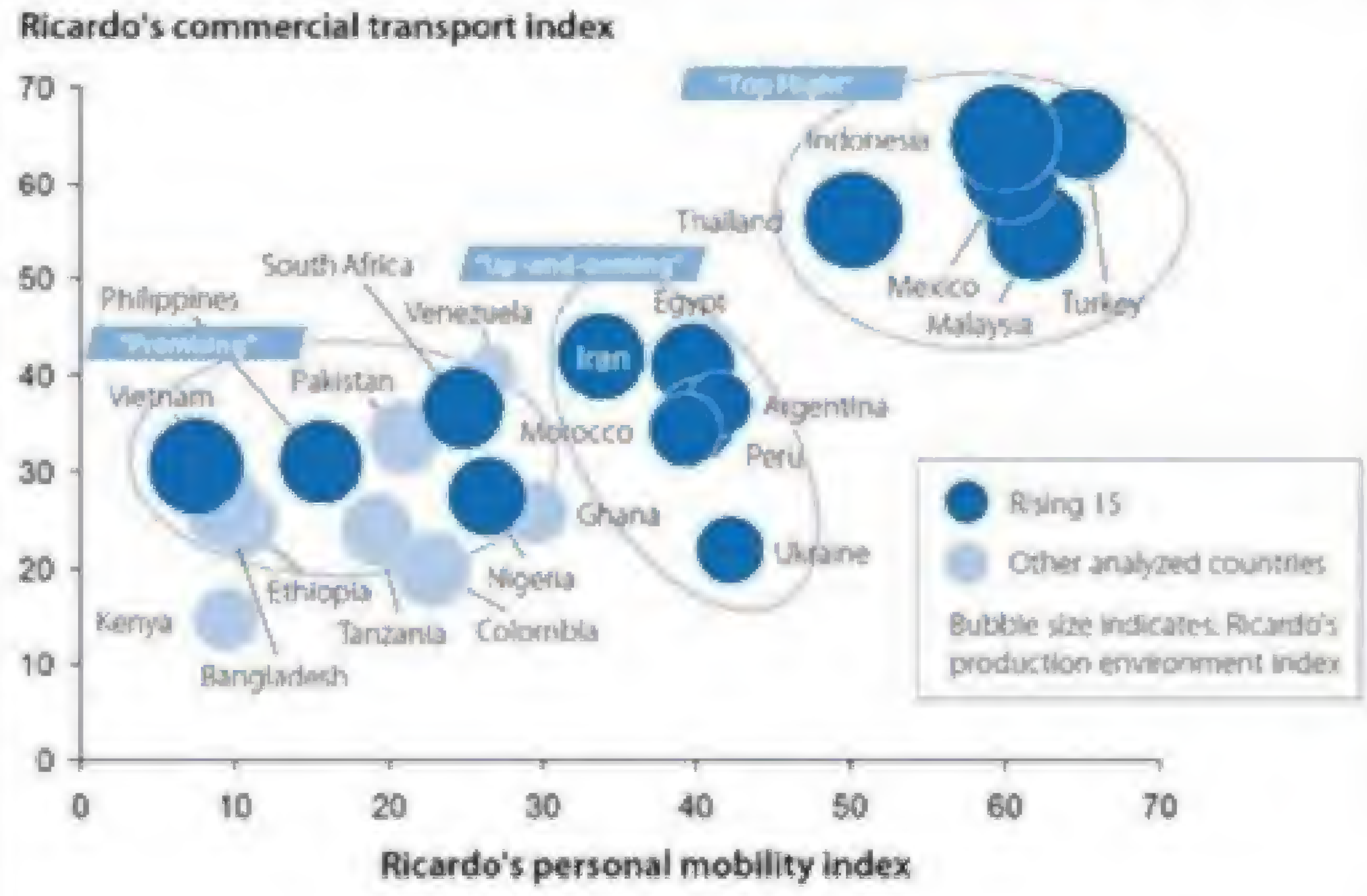
Ricardo study maps out the future for OEM sales growth

Well-known engineering consultancy Ricardo has released a study that could give OEMs a steer as to where they might need to focus their marketing, and therefore their future motorsport campaigns, in years to come.

The study, which has been compiled by Ricardo Strategic Consulting, was put together in order to provide insights into the longevity of the current growth pattern of the world automotive industry, and to highlight the most promising regions for future growth. With the latter in mind, it has named a 'Rising 15' group of countries where future growth is expected.

Ricardo set out to analyse and compare the key indicators for social and economic development. These included population size and growth, size and growth of the economy, social and scientific progress indicators, quality and extent of infrastructure, and the political and legal context. Indicators were developed from raw data to compare countries in regard to the market prospects for cars and commercial vehicles.



Of Ricardo's Rising 15 countries, just one - Malaysia - currently hosts a grand prix, although it looks quite possible that Mexico might be joining the F1 schedule soon (it was actually on a leaked calendar for 2014, though its place has not been officially confirmed). Turkey has lost its GP, while Thailand was planning on staging an event around the streets of its capital, Bangkok, before legislation scuppered the scheme. In the second tier of countries, Argentina held a grand prix for many years and there has been talk in recent times of a return, while Morocco hosts a successful WTCC counter. In the third tier, South Africa has hosted Formula 1 in the past, and again there has recently been talk of F1 returning to the country.

In summary, from 2020 onwards the study predicts that the engine for profitable growth will be - subject to political stability - the economies of the following automotive markets: Argentina, Egypt, Indonesia, Iran, Malaysia, Mexico, Morocco, Nigeria, Peru, the Philippines, South Africa, Thailand, Turkey, Ukraine and Vietnam.

Taken together, Ricardo's Rising 15 - which has a combined population of 1.2 billion - is already the third largest vehicle market in the world, with annual sales exceeding 8.5 million vehicles in 2012. Average annual growth across the Rising 15 has exceeded nine per cent for the past 10 years, while in most of these countries, Ricardo found, vehicle markets have grown faster than the economy as a whole.

Dr Andreas Schlosser, Ricardo Strategic Consulting managing director for central Europe, said: 'There have been winners and losers in the efforts of the current cohort of established global automakers to exploit growth within the BRIC [Brazil, Russia, India, China] region. The key strategic question now is where the next wave of growth-based opportunity will arise. By analysing the world's fast-growing economies in some detail, we have been able to highlight what we are calling the Rising 15 markets which will present the key opportunity to 2025 and beyond.'

SEEN: DALLARA FORMULA 4

Dallara has released a rendition of its forthcoming FIA Formula 4 car. The Italian company is one of six firms - including Mygale and Tatuus - that have registered with the FIA in the hope of gaining homologation for the new starter formula. Jos Claes, head of engineering and project management at Dallara, told *Racecar* that the company had already talked to a number of interested parties about the car. He also said that the released image should not be treated as the finished design: 'This is just an image, a rendering, and is not the result of the real car design that has started just recently,' he said.

The car is due to be completed by the spring of 2014 and Dallara says the new design will make extensive use of the in-house full scale simulator, that allows it to test engineering solutions and validate them with a driver before actually making a start on the car's build programme. Dallara also says it will draw on its Formula 3 experience with its F4, and that it will be designed with a variety of engine installations in mind, including the possibility of an electro-hybrid version.

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Scott snaps up NASCAR Sprint Cup team

Harry Scott Jr is the new owner of the Phoenix Racing NASCAR Sprint Cup outfit, after coming to an agreement with former owner James Finch to purchase the team.

Scott has committed to keeping the Phoenix Racing squad intact for the remainder of the season, with Nick Harrison staying on as crew chief. The team will also continue with its relationships and alliances with Chevrolet, Hendrick Motorsports and Earnhardt Ganassi Racing. The sale included the team's workshop in Spartanburg, South Carolina, and all its assets.

Scott said of the purchase: 'This is a very proud day for me as I will have the opportunity to compete against the best teams in motorsports in the NASCAR Sprint Cup Series as the owner of Phoenix Racing. I am going to build a championship contender with hard work, the right people and the right partners. This team has a great foundation thanks to the efforts of James Finch. There is a lot to build upon and I am looking forward to getting started.'

Scott's role as a co-owner in Turner Scott Motorsports (TSM) in the second tier Nationwide Series, and also the Truck Series, remains unchanged, and he will continue to play an active part in that team on and off the track. 'I owe a lot of gratitude to Steve Turner for bringing me into the sport as an owner. My experience at TSM will continue to serve me well in this next step,' said Scott.

Scott has signed a deal with Brandt, which also sponsors TSM in the Nationwide Series, to be the primary sponsor of the No 51 for three Sprint Cup races this season. Phoenix Racing, which was established in 1989, has one win, four top five and 15 top 20 finishes to its name.

Phoenix Racing was established in 1989 by James Finch

LAT

BRIEFLY

BTCC stick with Dunlop

Dunlop has confirmed that it has been re-appointed by the British Touring Car Championship as the official tyre supplier. This extends the sole-supplier partnership that began in 2003, although Dunlop has been actively involved in all eras of the championship since the BTCC began in 1958.

The new agreement is a multi-year contract and Dunlop will continue to supply all teams with their range, which includes Sport Maxx soft, medium and hard compounds and BluResponse wet tyres. The soft and medium tyre choice will be taken to all circuits apart from Thruxton, where the Sport Maxx hard tyre will be exclusively used.

'The BTCC is one of the most prestigious and important championships in Europe,' said James Bailey, motorsport communications and marketing director for Dunlop Europe. 'We are delighted to be re-appointed as official tyre supplier.'

Palmer: FIA Formula 4 not a threat to MSV F4

Motor Sport Vision boss Jonathan Palmer has told *Racecar* that he does not believe the introduction of the new FIA Formula 4 will have a negative effect on his own BRDC Formula 4 championship.

FIA Formula 4, which is to be a carbon-tubbed starter formula, has already garnered interest from chassis manufacturers (see left) while Ford has stated that it is considering switching Formula Ford to F4 in the UK. The FIA's intention is that the new formula should be the national starter category across the globe.

The new FIA F4 chassis will be to F3 safety spec and cost-limited to €40,000, while a budget 'target' of €100,000 has been set by the FIA.

However, Palmer – whose F4 championship was launched this year and has been very successful – doubts the FIA cost caps are workable: 'I will be very surprised if any manufacturer can actually sell a car for €40,000, ready to go, and I'll believe it when I see it. And similarly I don't believe for one moment that budgets will end up at €100,000,' he said.

With the above in mind Palmer does not think BRDC F4 – which runs with spaceframes to the new-in-2011 FIA standard – has anything to fear from the FIA interloper. 'Ultimately, I think it comes down to who's got the most appealing package, and that's down to the quality of the product and the cost of it. Those are the two fundamentals, and I'm very confident our BRDC/MSV Formula 4 package is going to continue to be the strongest because it's going to be the most affordable.' BRDC F4 cars cost £30,000.

Palmer owns the trademark for Formula 4 in the UK, but as yet has made no plans to take any action to restrict its use. 'I don't think the real issue is who owns the name, but yes we do own it. It's certainly mildly frustrating that we spotted there was a very huge gap in the UK single-seater market, and we addressed it quickly and effectively and we have been very successful with the BRDC F4 concept.

'It is slightly frustrating that the MSA appear to be looking at introducing another Formula 4 to compete with one that is doing a very good job, but I suppose they presumably feel obliged to implement an opportunity that the FIA are intending to present to them.'


BRDC F4 cars in action at Brands Hatch

Top F1 boss calls for more help for cash-strapped teams

McLaren team principal Martin Whitmarsh has said that Formula 1 should do more to help the poorer teams, particularly in the light of the increased costs associated with the new for 2014 engine formula.

Engine costs for next year are expected to rise by 100 per cent, and with the new V6 turbocharged powerplants not covered by the Resource Restriction Agreement, this could have a serious impact on the smaller F1 outfits, who already operate on budgets which are a fraction of those enjoyed by the top teams.


An expensive 2014 could spell problems for smaller F1 teams, says Martin Whitmarsh

LAT

Whitmarsh believes that something needs to be done to address this sooner rather than later, saying: 'Despite our best efforts, the costs next year are very stiff, I think, particularly for the smaller teams. I think those teams who have a strong association with an OEM have a good degree of financial stability, but it's very clear that we should be fighting for all 11 teams that we've got on the grid now. We should be fighting for their survival and making sure that they've got sustainable business models, because if we don't, at some point there will be a crisis, there will be the domino effect. We sometimes act better under crisis, but generally it's better to avert the crisis and work together beforehand.'

Meanwhile, Red Bull boss Christian Horner has warned that there are other changes in the regulations for 2014 which might also drive up costs. 'I think the reduction in wind-tunnel usage, in getting rid of aerodynamic testing and so on, will again have a significant impact on costs for next year. Of course, it depends where your cost drivers are, but I think we still have a responsibility as a group to not ignore costs and certainly 2014 looks to be a very, very expensive year.'

Whitmarsh's comments bring the disparities between the haves and have-nots into sharp focus. According to best estimates the top spending team in F1, Ferrari, currently has a budget of £250m, while Caterham's budget is just a fifth of that at £51m. Whitmarsh's McLaren organisation races with £160m a year, while Horner's Red Bull boasts the second biggest spend with £235.5m.

Silverstone agrees £32m development deal

The British Racing Drivers' Club (BRDC) has agreed a deal with property company MEPC to lease out land around the Silverstone circuit for long-term development.

MEPC has acquired the lease, which runs for the next 999 years, for £32m. The land includes the existing Silverstone Industrial Estate and other development land around the outside of the circuit (see orange area on map) on which planning permission has already been granted. But the agreement does not stretch to the management or development of Silverstone Circuit itself.

MEPC is owned by the BT Pension Scheme, the UK's largest corporate pension scheme. The £32m it has paid the BRDC has now enabled the club to pay off its long and short-term loans from Lloyds Bank and Northamptonshire County Council.

Stuart Rolt, chairman of the BRDC, said: 'The BRDC board was given a mandate three years ago to attract suitable partners to invest in Silverstone and help realise the full potential of its 760-acre estate. Over three years, the board has given consideration to a number of offers from credible parties and we are delighted to have reached an agreement with MEPC, which was selected on the grounds of its financial standing, reputation, the quality of the developments it has undertaken – and continues to own – and the price it was prepared to pay.'

Rick de Blaby, CEO at MEPC, said: 'When we were approached with the BRDC's vision of what Silverstone might become in its next iteration, it was easy for my colleagues and I at MEPC to relate to such ambition. The creation of great business estates, with clusters of particular commercial activity that have a sense of place and community, is what we do. That the BRDC had secured planning consent for its masterplan is to its great credit and we are, of course, hugely cognisant of the immense history of Silverstone and its current standing today, not just as a venue for world-class motorsport, but as a centre for high-end precision engineering.'

The BRDC says that it has agreed terms with a 'suitable partner' to further develop and invest in the circuit.

However, under the terms of non-disclosure agreements, the BRDC was not able to comment on any details as *Racecar* went to press.


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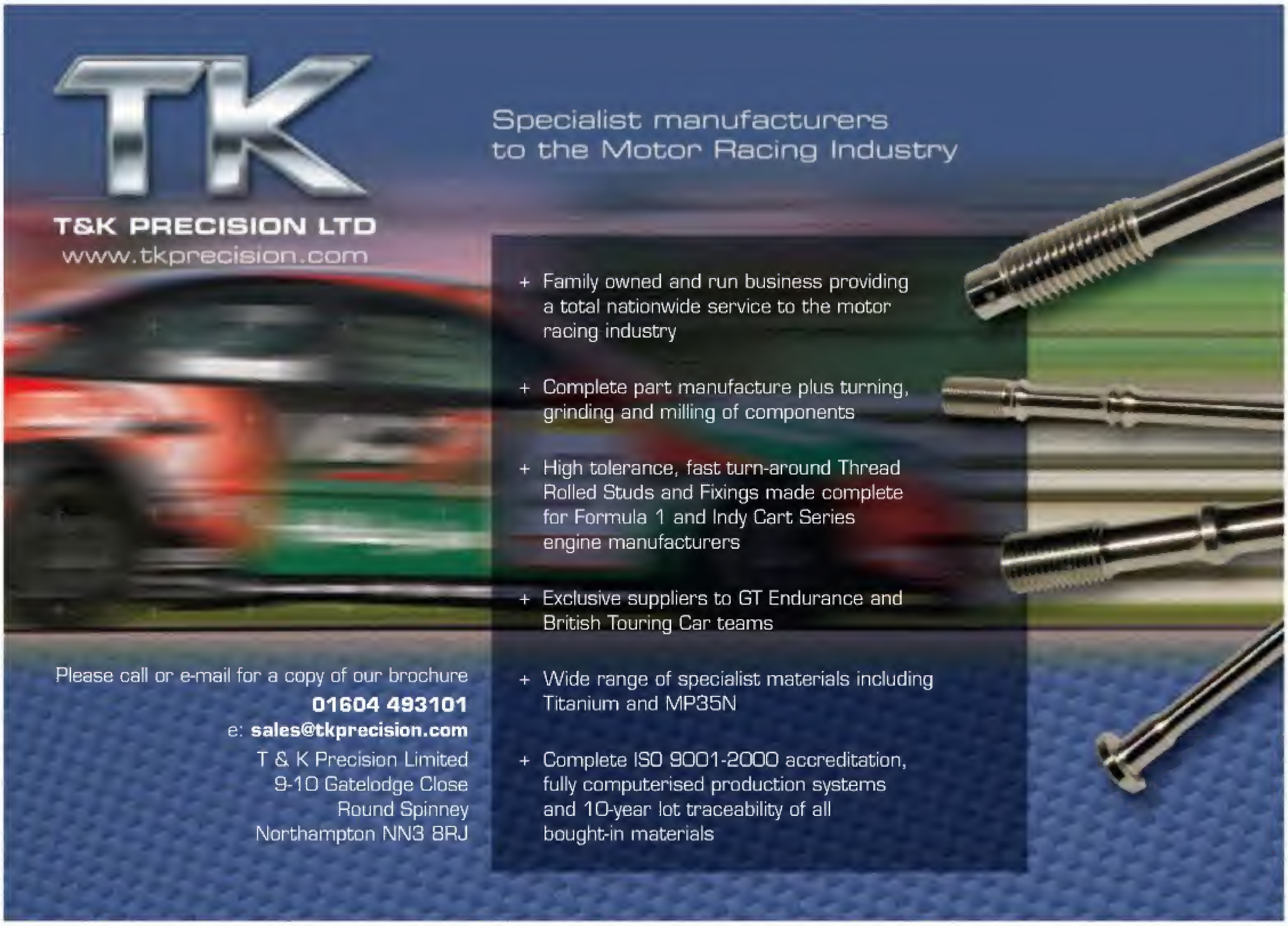
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SEEN: MERCEDES CLA VLN

At the Frankfurt Motor Show, Mercedes revealed a 'low cost' customer racing car based on its new CLA model. The catchily named CLA 45 AMG Racing Series 'showcar' was a ready to run concept with a 360bhp turbocharged inline four. The engine is essentially the standard unit fitted to the production car.

Many other production car parts such as the transmission and dash carry over in an effort to keep costs down.

If AMG decides to put the car into production, it should be ready for customers in time for the 2014 VLN season where it can contest the V1-3 classes, and will retail for under €100,000.

Caterham launches new AeroSeven concept car

Caterham cars has launched its new road car, the AeroSeven, which draws heavily from its Formula 1 team methods and is the first Caterham road car ever to be fitted with traction control.

The car is currently fitted with Ford's Duratec 2-litre engine that produces 237bhp and delivers peak power at 8500rpm. Power is delivered through Caterham's six-speed manual transmission. Thanks to a newly developed Caterham Engine Management System, drivers will be able to enjoy fully-adjustable traction and launch control functionality.

An updated interpretation of the Seven CSR platform, the carbon-fibre bodied concept vehicle, has styling that gives clues as to what the new car, tabled for 2016 and under development with Renault, will look like.

Graham Macdonald, managing director of Caterham Cars, said: 'Over the coming years, we will be expanding our range of sportscars as we look to meet the differing needs and desires of potential customers. The AeroSeven Concept is the first model in that journey.'

Delivery of the production version of the concept model will begin in autumn 2014.

Dassault on Safe ground with purchase of simulation firm

French design software giant Dassault Systèmes has snapped up British fatigue simulation company Safe Technology for an undisclosed sum.

Safe Technology Ltd is at the cutting edge of fatigue simulation, used for predicting product durability. It is the developer of the fe-safe durability simulation application suite, and has more than 500 customers, including General Motors, Caterpillar, Honda Jets, Harley Davidson Motor Company and Hyundai Motors.

Dassault, which is well-known for its 3D design and simulation software – such as Catia, Solidworks and Simulia – says that Safe is a good fit for the company, and while neither party would comment on the financial details of the deal it was an 'all-cash transaction', Dassault tells us.

Bernard Charles, president and CEO of Dassault Systèmes, said of the deal: 'Consumers want a product that is built right. They want a product that lasts. Durability deeply affects the emotional attachment between brands and their users. The 3DEXPERIENCE [a Dassault product] platform is all about building brand loyalty for a company's business and the products it offers. This is why Safe Technology is such a good fit for Dassault Systèmes.

'Advanced fatigue and durability software solutions are an essential part of the product design process. Safe Technology will enhance Dassault Systèmes' Simulia structural simulation to predict and analyse product life quickly and accurately.'

John Draper, founder and CEO of Safe Technology, said: 'Safe Technology has been working closely with Dassault Systèmes and its Simulia applications for more than 15 years and in that time has developed cutting-edge technology that we deliver to a global customer base. We enjoy significant synergy with Dassault's business strategy and ethos and as such, we are proud to be joining their operation.

'Dassault Systèmes is committed to keeping fe-safe at the forefront of fatigue technology as well as to delivering an open solution that supports all the leading FEA solvers.'

CAUGHT

The West Surrey Racing-run BMW 125i driven by Colin Turkington in the third British Touring Car Championship race at Knockhill lost its fourth place finish after a post-race technical inspection found that the engine in the hatchback BMW had been over-boosting during the race. The driver lost the 13 points for fourth but already had a hat-full after winning the first two counters of the day.

PENALTY: 13 points

Pat Tryson, crew chief on the No 30 Turner Scott Motorsports Chevrolet in the NASCAR Nationwide Series, has been fined $10,000 after the car failed to meet the minimum ride height at the front during post-race inspection at the Atlanta Motor Speedway round of the championship. Tryson has only recently started working with the Turner Scott Motorsports team, the owner of which – Harry Scott Jr – was docked six points in the owners' championship for the infraction. Driver Nelson Piquet Jr also took a six point penalty in the drivers' standings.

FINE: $10,000

PENALTY: six points

Trent Owens, crew chief on Turner Scott Motorsports' second Nationwide car, the No 32 Chevrolet, was also fined $10,000 for the same infraction as the No 30 car (see above) at Atlanta. Owner Harry Scott Jr and driver Kyle Larson both lost six points as a result of the measurement misdemeanour.

FINE: $10,000

PENALTY: six points

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PEELING BACK THE STICKERS NO19: SHELL

You might not have noticed, but there was a little bit of a commotion at the end of the Belgian Grand Prix. Greenpeace had chosen the Spa podium ceremony for a demonstration meant to highlight race sponsors Shell's activities in the Arctic, but the TV director at FOM tried to make sure the world did not see the pictures.

So Greenpeace's first flirtation with F1 did not result in much exposure, which is ironic as Shell has had plenty of publicity from its involvement in F1 over the past 17 years. Doubly ironic, in fact, for Shell's sponsorship deal with Ferrari co-incided with another environmental hoo-hah in the first place.

Shell, which spends some $36m for its prime location on the Ferrari F138 sidepod, was first a sponsor of the Scuderia in the 1950s, before Enzo Ferrari switched to a long term deal with Agip. Shell reduced its involvement in F1 in 1973, in the wake of the fuel crisis, but was back in with McLaren by 1985. However, McLaren's switch to Mercedes power - which was wedded to Mobil1 - meant Shell was out of an F1 deal for 1995.

At about this time Shell was also facing a great deal of negative press in Germany - chiefly because if its intention to sink an oil rig in the North Sea - and had even seen some of its petrol stations attacked. With German hero Michael Schumacher going to Ferrari for 1996, the company saw - and grasped - an opportunity. The deal was re-signed in 2010 (until 2015), so it seems Shell is very pleased with its exposure. Perhaps Greenpeace should consider backing a Formula 1 team?

BRIEFLY

New face for IMSA

IMSA has announced a new watch partnership with Swiss watch manufacturer Tudor for its USCR championship which starts at the Rolex 24 at Daytona in January.

New LMP2 for ADESS

ADESS AG has revealed that it will build a customer LMP2 in 2014. The ADESS-02 appears to be an update of the Lotus T128 LMP2, which Adess developed on behalf of Kolles-Kodewa. That relationship ended in the courts as a result of disputes over unpaid bills. Adess has also developed the chassis for the Nissan ZEOD, but it will not be the same as the tub used in the LMP2. The '02 retains the bespoke transmission used in the T128 as well as its torsion bar suspension.

WTCC milestone

The WTCC hit a milestone in Japan in October as it hosted its 200th race, won by Tom Coronel. So far 190 drivers from 34 countries, at the wheel of cars built by 10 different manufacturers have taken part in at least one race.

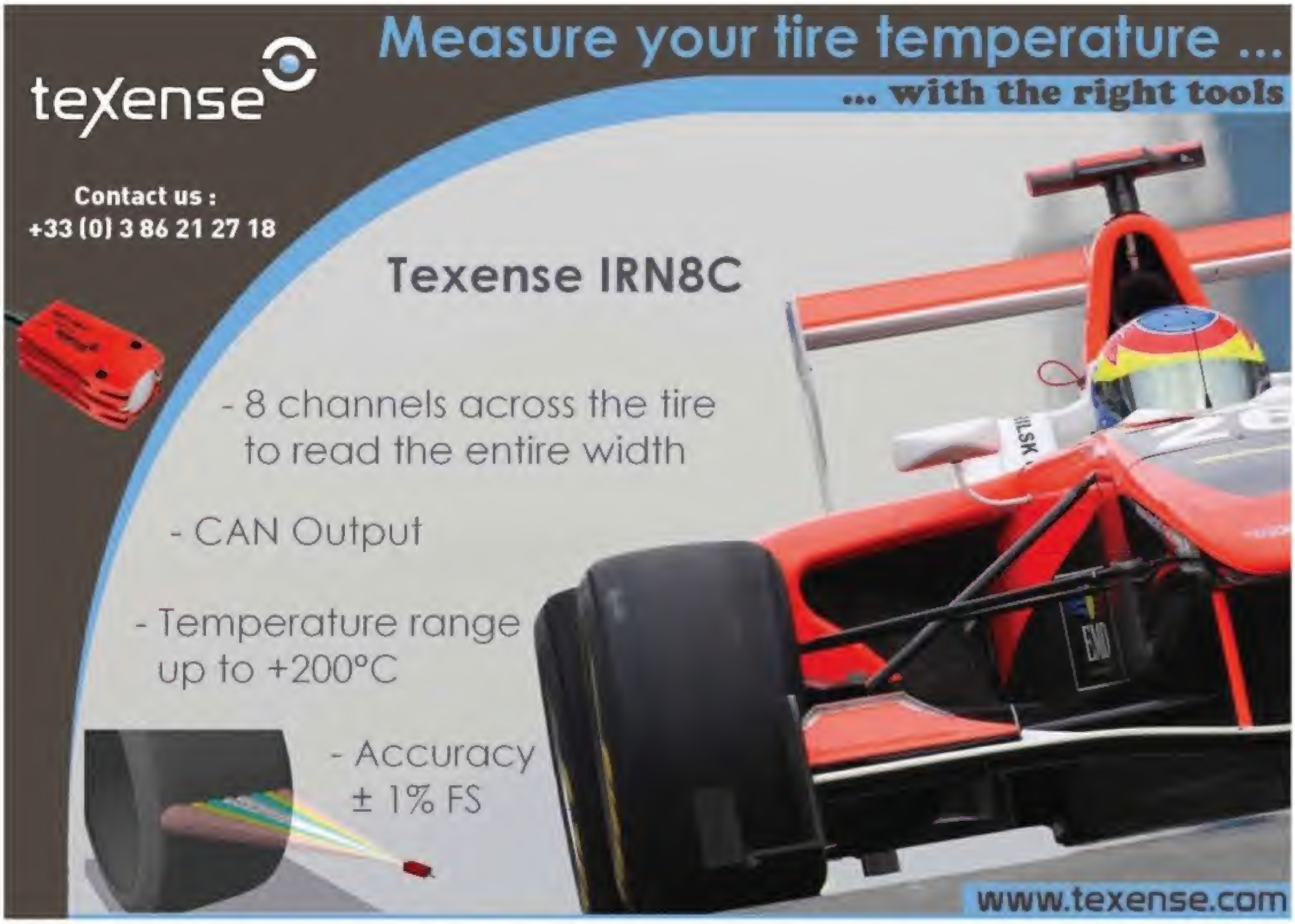
Lister Cars returns to its roots to bring back a 1950s classic

Lister Cars, one the greatest names in British sports car manufacturing, will return to its Cambridge, UK, roots to reinstate production of an exciting new car.

The three Lister companies of George Lister Engineering of Cambridge, Brian Lister Light Engineering and Lister Storm, have been reunited into one organisation that will herald the return of the 1950s Lister 'Knobbly' Jaguar. The car will be built using many of the original working drawings, manufacturing jigs and personnel.

The cars will be built to be identical to those of 1958, and will be race-ready 'out of the box' to race with BHL-C (C for Continuation) chassis insignia and up to FIA/HTP Appendix K specification.

Race proven, Jaguar D Type-specification engines and D-type gearboxes will be supplied by Crosthwaite & Gardiner, and all race preparation and track commissioning will be undertaken by Chris Keith-Lucas of CKL Developments, another leading specialist in historic Jaguar restoration and preparation. The body will be recreated using the original Shapecraft body bucks by Clive Smart and Adrian Breeze.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INTERVIEW: BRIAN SIMS - SPONSORSHIP GURU

Brian Sims is a well-known sponsorship hunter and the founder of the Motorsport Industry Association (MIA). His varied career in motorsport started as a driver, including racing in Group C, while he has also worked in Formula 1 as a marketing director with Lola and Benetton and has had a spell as the manager of the Kyalami racetrack in South Africa. Currently Sims lectures on sponsorship acquisition - he is a regular guest lecturer at the World Academy of Sport - while he is also on two advisory boards at Oxford Brookes University, where he is a consultant in international motorsport.

How did you get into the sponsorship business?
I got into it in the 1970s. I wanted to go motor racing, so I went and found sponsorship to get my first car. So I got the sponsorship before I started racing.

Basically, it was very simple. I went to a new nightclub that was opening up near Brands Hatch and in quite an audacious way I got the attention of the new owner by putting a Formula Ford racing car, which I'd borrowed, on a trailer in the middle of the car park at a busy lunchtime at this club, where they did business lunches. And when the manager came out to complain that it was blocking the car park, I said: 'well have a look at how many people have pulled up and are looking at that car.

'Imagine if that was in a shopping mall in Maidstone, in your own individual colour scheme, with the promotional girls selling memberships to your nightclub around it.'

We talked and I eventually did the deal with him. After that I was never, ever without sponsorship for the rest of my driving career.

How has the motorsport sponsorship market changed since you were first involved, in terms of the way people go looking for money?
Sadly - and I think this is a very poor reflection on motorsport - I don't think it has changed very much, quite frankly. I think motorsport has completely lost touch with the fact that the world has changed. People are still going out in exactly the same way looking for sponsorship based on brand awareness, hospitality and PR.

I've done around 80 sponsorship deals in my career, valuing around £65m, and the common thread through nearly all of those deals is that they were not based on brand awareness - apart from Chesterfield, which was tobacco, that was brand awareness. But the majority of the deals were based upon a huge amount of research that I did, and the offering of some measurable, sustainable, business development opportunities.

Could you give an example as to how that works?
I brought FedEx into Formula 1. I did it by doing a lot of research about the amount of courier business that Benetton - where I was then the marketing director - did as a company, and also all the other sponsors on the car, how much they did.

Then I got a meeting with the president of FedEx Europe, based on the fact that I had let him know how much business Benetton had done the year before with couriers, and also how much courier business the other partners - from Goodyear through to Akai - also did. That got me the meeting, and eventually, within four-and-a-half months, I'd signed a deal for £15m.

How has the sponsorship market changed from the sponsors' point of view?
The thing that's changed, from the point of view of the corporate world today, is that the word that creeps into conversations more than any other is 'perception'. Motorsport is seen to be a sport that has become ridiculously expensive. I mean, a driver now going into Formula 1 has to take a budget of £6-8m with him. Motorsport is not doing itself any favours, because it's not taking any action internally to try and resolve this issue, where it's only very, very wealthy kids that can go motor racing.

To Infiniti and beyond

Infiniti is to give a couple of engineering graduates the opportunity of a year's work at the Red Bull F1 team in an all-new global tech talent search.

The Infiniti Performance Engineering Academy will see two winning candidates complete a 12-month assignment with the three-time world championship-winning outfit, with the lucky winners working alongside Infiniti engineers already based at the F1 team's Milton Keynes factory. They will also spend time at Infiniti's nearby technical centre in Cranfield, where they will work on future road car technologies.

Recruitment will open later this year, and national selections across several global regions will begin in May 2014. These will put applicants through a comprehensive selection process to assess their performance potential and their ability to think innovatively.

Finalists will then present their ideas to a panel of senior technical figures from Infiniti and Red Bull Racing in July 2014, with the two winners announced at the British Grand Prix. The placements will begin in September 2014 and the scholarship will include a salary, accommodation, and even the use of a car.

Adrian Newey, chief technical officer at Red Bull, said: 'One of the key advantages of our partnership with Infiniti is our ability to utilise their resources, from materials to processes and people. As such it is really interesting for us to benefit from

Two lucky graduates will work with the Red Bull F1 team

LAT

a worldwide selection process which brings the best new talent through our door.

'The speed of technical development in Formula 1 means that fresh thinking is crucial in keeping ahead of the other teams and we hope that providing an opportunity for world-class graduates to work with us will provide long-term performance benefits for us and for Infiniti.'

Infiniti tells us that further details of its Performance Engineering Academy, including how to apply and when recruitment starts, will be released in due course - so look out for updates in future issues of *Racecar*.

You setup the MIA in 1994 to help motorsport businesses, but just how healthy is the UK motorsport industry today?
When you lose companies the size of Lola, as we have, something's gone very wrong. But I think what is good is that a lot of companies have diversified, which is fantastic. I think the motorsport world, generally, lives in a bit of a bubble. But the industry, in terms of the businesses involved, has been very imaginative and has done tremendous things, and I take my hat off to them.

What else are you involved in these days?
I'm on the advisory board of Oxford Brooks University, I'm a consultant. In effect I'm their motorsport industry liaison consultant. I work with the Formula 1 teams and businesses within Formula 1. We've got more graduates out there in the Formula 1 world than any other university. The reason for this, I think, is that it's probably a more practical university than others; a lot of the other universities are fairly theoretical, whereas Oxford Brookes is open 24/7, and they've got a complete motorsport technology centre.

BRIEFLY

World Rally-X

IMG Motorsports, the promoter of the FIA European Rallycross Championship, has announced that it's to create an FIA World Rallycross Championship. It also says that if the necessary approval from the World Motorsport Council is gained then it could be launched as soon as next year.

The new championship would feature events across several continents, with rounds in Turkey, Morocco, USA and in the Middle East joining the established European events. Long-term there might also be rounds in Brazil, Australia, China and India, IMG tells us.

F1 bosses back Todt in FIA presidency race

F1 team bosses have given incumbent FIA president Jean Todt a vote of confidence as he starts his campaign to retain his position as the head of the governing body for world motorsport.

Todt, who has been FIA president since 2009, will face competition from David Ward in the forthcoming elections, the latter having now officially thrown his hat into the ring. Ward was until recently head of the FIA Foundation road safety division, a position he has stepped down from in order to contest the election, and before that was a key aide to former president Max Mosley. He has now released a manifesto in which he says he intends to improve the 'effectiveness and accountability' of the organisation.

However, F1 team bosses seem to be wary of any change at the top of the sport at this time, and McLaren boss Martin Whitmarsh has given Todt a huge vote of confidence: 'Jean hasn't used this sport for his own ego, which I think is very tempting. I've seen and survived so far three presidents – only just, one of them – and I think Jean has acted in the interests of motorsport. For some people there hasn't been enough commotion, action and controversy around him. Those are good in some people's minds, but I think for those of us that participate in the sport, having some consistency, with someone who takes decisions that are in the interests of the sport quietly and efficiently is very beneficial.'

Mercedes team principal Ross Brawn agreed: 'Stability and consistency are very important. Jean has taken a quiet line, particularly in terms of F1, and that is welcome. And I think it's important that we have that continuity. Jean has stabilised the situation and now wants to move on to progress things and I know the huge commitment he makes to the sport overall.'

Red Bull team principal Christian Horner added: 'He's done a very good job so far.'

The elections for the presidency of the FIA will take place in December.

RACE MOVES

Carlos Tavares has stepped down from his position as chief operating officer at French car giant Renault. Tavares, a keen motorsport fan who races a 2005-spec GP2 car in EuroBOSS, is moving on to pursue personal projects. At Monza, Renaultsport chief **Jean-Michel Jalinier** insisted that Tavares's departure will have no bearing on the company's F1 engine programme.

Chip Wile is the new president of Darlington Raceway, taking over from **Chris Browning**, who has been in charge at the International Speedway Corporation owned facility since 2004. Wile has a background in NASCAR PR, and comes to Darlington via a stint at Motor Racing Network, where he was director of business development.

Audi WEC race engineer **Leena Gade** is now ambassador for the FIA Commission for Women in Motorsport. The British engineer tends the number 1 Audi R18, and has looked after Le Mans 24 Hours-winning Audis in both 2011 and 2012.

Cameron McConville, a former V8 Supercars driver and current driving standards observer for the championship, has now taken on an extra job as Porsche Cars Australia Motorsport manager. McConville replaces **Jamie Blaikie** as the head of Porsche's motorsport efforts down under.

Peggy Bishop, wife of IMSA founder **John Bishop**, and listed as a co-founder of the US sportscar sanctioning body in her own right, has died. The Bishops, who founded IMSA with Bill France Sr, sold the organisation in 1989.

Veteran NASCAR crew chief **Pat Tryson** has returned to the Nationwide Series to oversee the No 30 Turner Scott Motorsports (TSM) Chevrolet, driven by **Nelson Piquet Jr**. Tryson was previously the crew chief for **David Reutimann**'s No 83 BK Racing Toyota in the Sprint Cup.

Chris Carrier, **Nelson Piquet Jr**'s former crew chief at TSM, has moved on to crew chief the No 96 Chevrolet driven by **Ben Kennedy**, the great-grandson of NASCAR founder **Bill France Sr**, in the NASCAR Camping World Truck Series.

NASCAR Sprint Cup crew chief **Rodney Childers** is no longer at Michael Waltrip Racing, where he was crew chief on the car of **Brian Vickers**, having been released early following the announcement that he is to move to Stewart-Haas Racing next season to tend the **Kevin Harvick** entry. Childers remains under contract with MWR until the end of December, so he is unable to start working at SHR until 2014.

Marussia team principal **John Booth** (above) as said that the Formula 1 outfit is in no rush to appoint a new technical director to replace **Pat Symonds** – who attended his first race in his new job as Williams technical director at the Belgium Grand Prix. Booth said the team was now trying to decide whether it needed to focus on recruiting a tech director with design strengths, or one with greater organisational ability.

Scott Miller has stepped into the breach left by the departure of Childers at MWR, and is now interim crew chief on the Vickers car. Miller, who is the organisation's vice-president of competition, is an experienced crew chief with seven Sprint Cup race victories to his name. Meanwhile, race engineer **Billy Scott** is to take on more responsibility when it comes to car setup and race weekend preparation on the Vickers car.

Bryan Berry, a crew chief in the NASCAR Camping World Truck Series, was fined $2500 for an altercation involving a member of his crew – actually the girlfriend of his driver **Mike Skeen**, who slapped rival driver **Max Papis** after he criticised Skeen in a post-race interview. The woman in question, **Kelly Heaphy**, was also fined $2500, and has now been indefinitely banned from attending NASCAR events.

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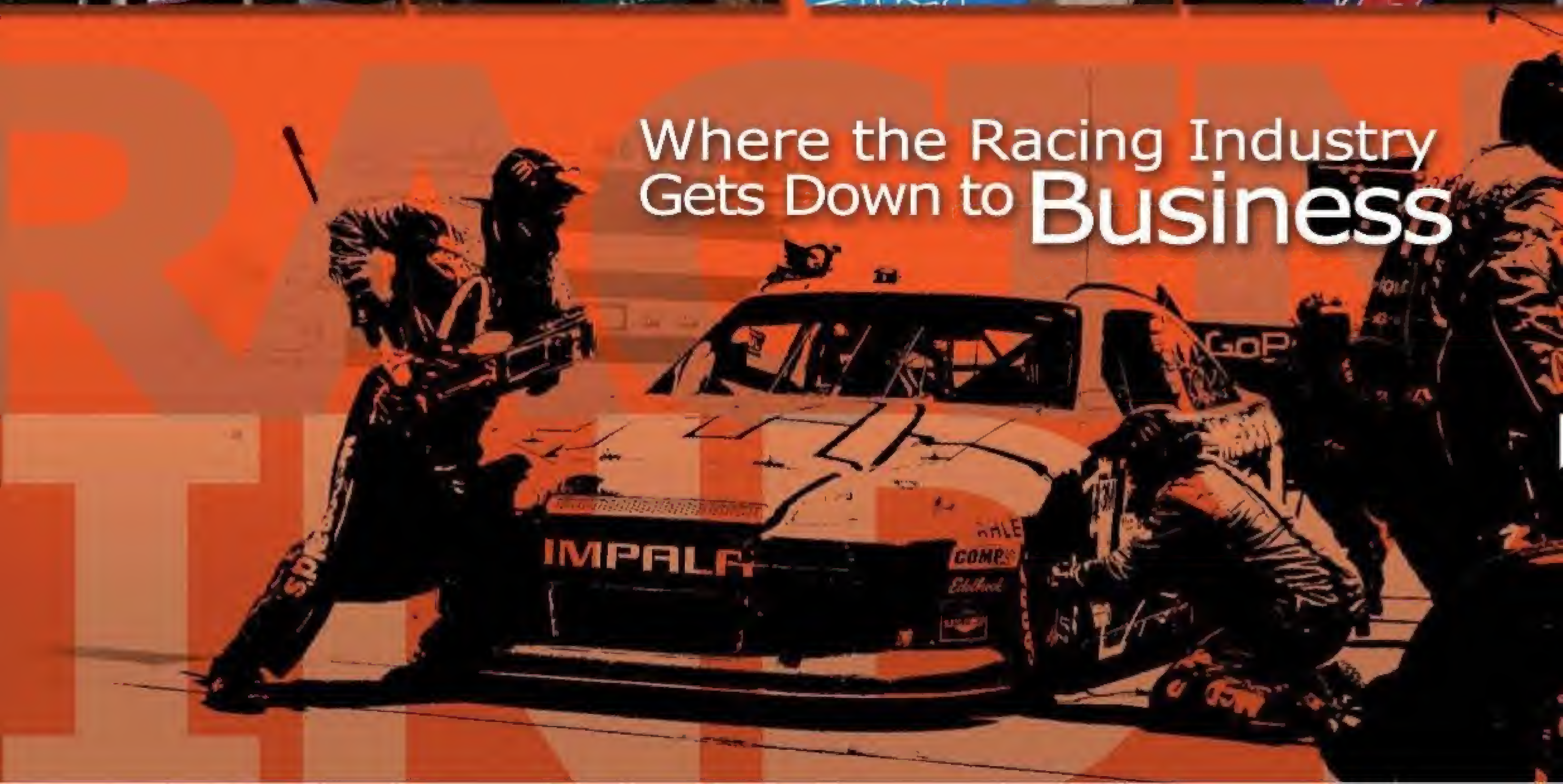


Where the Racing Industry
Gets Down to Business

OBITUARY – KARL-HEINZ KALBFELL

Former BMW motorsport boss Karl-Heinz Kalbfell has died at the age of 63, having succumbed to injuries which were the result of a historic motorcycle racing crash at Brands Hatch.

The German, who was an enthusiastic bike racer and regularly raced at the Goodwood Revival meeting, ran wide at Druids during a practice session and then fell from his machine on the run down to Graham Hill Bend. His injuries were a result of being hit by another competitor, who was following close behind and was unable to avoid him.

Kalbfell joined BMW in 1977, after a spell working in the caravan industry, and went on to head the legendary M Performance arm at the Bavarian company from 1988, becoming responsible for its motorsport activities.

Among the decisions attributed to Kalbfell was the switch from DTM to Super Touring in 1992, while he also played a large part in the development of the engine that motivated the 1995 Le Mans-winning McLaren F1.

Kalbfell also oversaw BMW's return to Formula 1 in 2000, in the back of the Williams, but perhaps his greatest success was a year earlier, with a win at Le Mans for the Williams designed and built BMW V12 LMR in 1999.

He left the BMW motorsport role in 2000, with Gerhard Berger taking on the job, but remained with BMW companies Mini and Rolls Royce. He finally left BMW for good in 2004 but stayed in the motor industry, working as CEO of Maserati and Alfa Romeo, and more recently on the board at Lotus in an advisory role. But it is for his time at Munich that he will be surely remembered. BMW said of his passing: 'We received the news of the tragic accident with great sadness. BMW Motorsport mourns an amazing person and a passionate racer. For many years he was a formative figure and a driving force behind BMW Motorsport and BMW M.'

Karl-Heinz Kalbfell
1949-2013

As motorsport boss, Kalbfell guided BMW to Le Mans victory in 1999


LAT

SPONSORSHIP

The Lotus F1 team has signed a two-year sponsorship deal with **Emaar Properties**, the Dubai-based residential and commercial property company which can boast the gargantuan Dubai Mall and the world's tallest building, the Burj Khalifa, in its portfolio. The Emaar name now has a prominent position close to the cockpit on the Lotus E21.

Formula E has signed up **Qualcomm** and **DHL** as sponsors as it builds up to its launch in the autumn of 2014. US technology group Qualcomm has penned a deal to become a technology partner of the new electric racecar championship - which intends to use its wireless charging technology from 2015 - while DHL is to be FE's logistics partner.

RACE MOVES

Simone Piattelli Palmarini now heads up public relations for Infiniti EMEA (Europe, the Middle East and Africa). Piattelli Palmarini spent four years (2000-2004) as corporate and product communications manager at Ferrari, but he started his career as a journalist, writing for national newspapers in his native Italy.

David Hart has been hired as the director of communications for IMSA, the body that's to run the new for 2014 United SportsCar Racing series. Hart will start work at IMSA once he has completed his duties at Grand-Am team 8Star Motorsports, where he is director of marketing and communications. Prior to joining 8Star at the start of this season, Hart spent 15 years in NASCAR at Richard Childress Racing (RCR).

Nate Siebens has been promoted to senior manager at IMSA Communications. Siebens joined the NASCAR Integrated Marketing Communications team full-time in January 2013, continuing a career in motorsport PR which has seen him work in NASCAR, ALMS, Grand-Am, IndyCar, CART/Champ Car and motorcycle racing. Prior to rejoining NASCAR in a new role this year, Siebens had been operating his own PR company since 2007.

There's been a shakeup in the management structure at V8 Supercars, the company that manages Australia's premier motorsport series. Chief financial controller **Peter Trimble** and head of international relations **Adam Firth** have both now left the company, the former to be replaced by **Cameron Price**, while chief operating officer **Shane Howard** will take on Firth's responsibilities.

Jonathan Walker has been appointed managing director of Mahle Aftermarket Ltd, the UK subsidiary of the German filtration and engine component manufacturer. Walker has been recruited from Mahle Filter Systems UK in Telford, where he had been head of design/quality/development engineering for air induction systems and filtration for the past seven years. He has over 20 years experience in the automotive industry.


LAT

Niki Lauda (pictured), the three-time F1 world champion and current non-executive chairman of the Mercedes F1 team, was presented with the Bernie Ecclestone Award 2013 by Brembo at the Italian Grand Prix. Lauda, currently the subject of the Hollywood movie, *Rush*, was given the award for his 'legendary races and his sporting and entrepreneurial capabilities'.

Dale Wells, the long-standing competitions manager at the BARC (British Automobile Racing Club) is to step down from the role to take early retirement. Wells (62) had held the full-time post at the BARC's Thruxton HQ for 23 years.

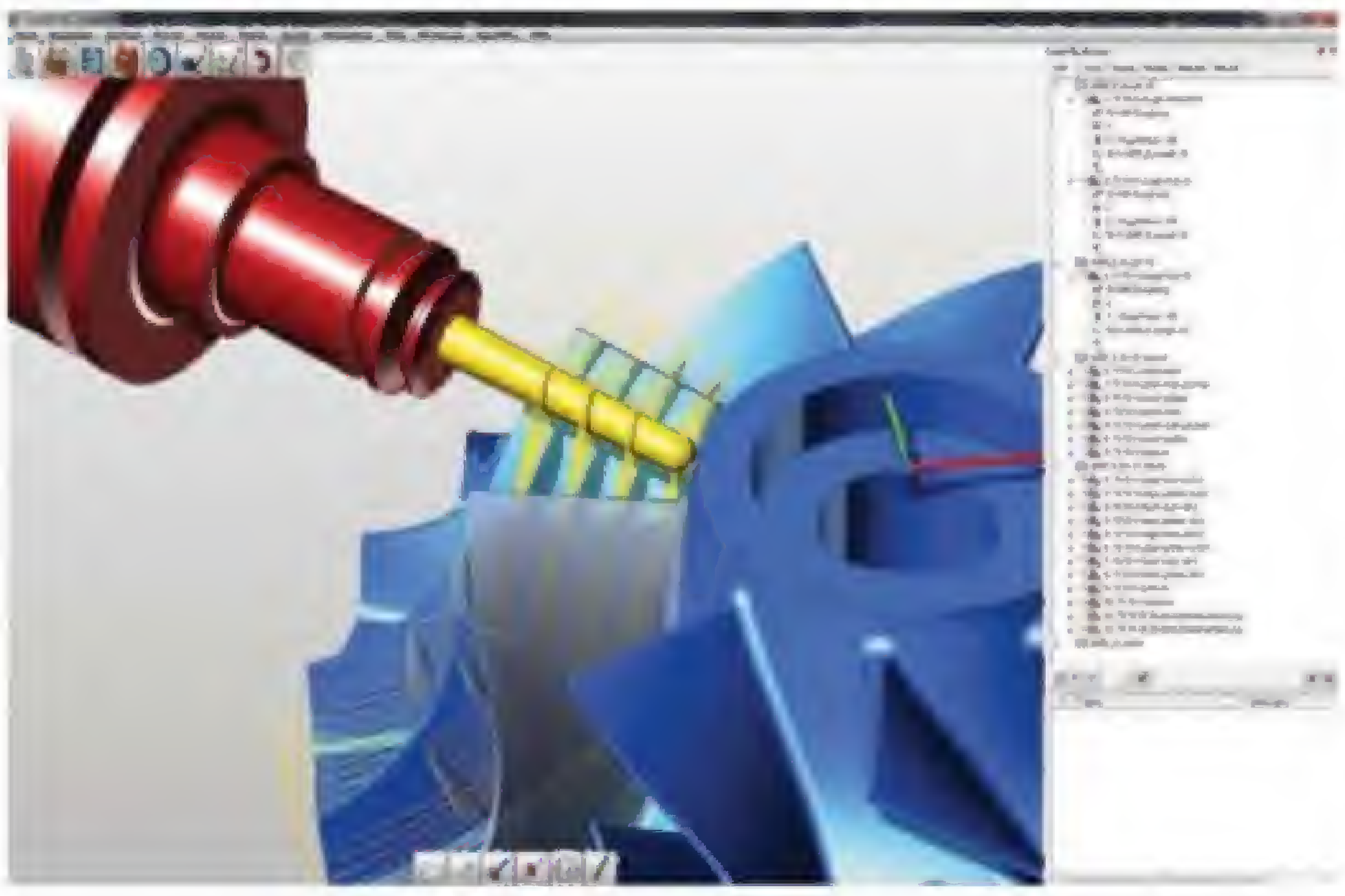
NASCAR Sprint Cup crew member **Eric Maycroft** has been indefinitely suspended from all the US stockcar governing body's competition for violating its strict substance abuse policy.

Meanwhile, NASCAR has reinstated former Nationwide Series crew member **Robbie Harrison** upon his successful completion of its Substance Abuse Policy Road to Recovery progamme. Harrison had been indefinitely suspended from the sport in May of this year.

Moving to a great new job in motorsport and want the world to know about it? Or has your motorsport company recently taken on an exciting new prospect? Then send an email with all the relevant information to Mike Breslin at bresmedia@hotmail.com

SOFTWARE

Open Mind synergy between CAM and CAD with hyperCAD-S



Open Mind Technologies says that its hyperMill 2013 CAD software offers a variety of new features, extensive functional upgrades as well as greater ease of use.

The most significant advance is the hyperCAD-S CAD core, which is matched to the company's hyperMill CAM solution. Rather than using existing CAD packages, Open Mind decided to launch its own CAD solution for its hyperMill CAM software, in order to provide better feature integration.

Within hyperCAD, users can easily modify any of the geometry elements at any time. Curves and free-form surfaces are depicted using Bézier and Nurbs geometries.

As well as all of the standard basic design elements it offers, the core also provides a number of features that specifically aid CAM programmers, including tool paths, polygon networks, point clouds and a rectangle element.

Additionally, the system maps the mathematical definition of elements, such as cylindrical, level, free-form, rotary and other surfaces.
www.openmind-tech.com

MANUFACTURING

Formaplex expanding

UK-based advanced manufacturing specialist Formaplex, based in south east Hampshire, UK, recently announced that it will expand its metallic five-axis CNC capacity by a third. This will be music to the ears of teams competing in Formula 1 and sports car racing which require extensive supplier support.

The expansion is made possible by the order of two additional DMG five-axis machines, including the DMU 100 eVo - the first in the UK - and a DMU 80 eVo. These are in addition to the 31 CNC machines already in production across the companies' six manufacturing sites. Once installed, the machines will service F1 clients exclusively for the first six months. They will then be used for machining of metallic tooling, manufacture of components, composite moulds, wind tunnel tooling and jigs and fixtures.

The DMU 100 eVo machine features a working envelope of 1000x900x700mm.

The DMU 80 eVo is smaller, with an envelope of 800x650x550mm.
www.formaplex.com

WHEEL GEOMETRY

BG Racing

Stringing is one of the oldest and best proven methods for quickly ascertaining factors such as toe-in on a car. Though laser-based systems can be more accurate, they do not come cheap. For the budget-conscious racer, this new string line setup from BG Racing is an option.

The frame is fully adjustable to allow fitment to a wide range of cars and attaches to the vehicle using the rubber-coated hooking arms. Additionally, the string bars have a number of pre-machined grooves for the strings to locate in, allowing for different car widths to be easily accommodated.

Also new from BG is a slimline quick release steering boss. With a depth of just 26mm, it allows for the quick attachment and removal of wheels where space is limited. It is produced from high-grade aluminium and features both a push pin and twist lock securing mechanism to ensure it stays attached.
www.b-gdirect.com

LASER ETCHING

Foba M1000 compact mobile or desktop laser marking station

Laser etching is a useful factor in ensuring parts can be easily identified and traced. The Foba M1000 compact manual laser workstation has been designed for laser marking and engraving of both single workpieces and batches of small-to-medium-sized metallic and plastic components.

The new laser class 1 marking station is equipped with a programmable Z-axis (for positioning the marking laser), and a 450x250mm work table allowing for a wide range of components, from con-rods to rod ends, to be accommodated. A range of fibre marking lasers are available for integration into the M1000 to suite different material applications.

The M1000 is supplied with integrated lighting, a large window and an exhaust nozzle as standard. On request, the workstation can also be equipped with a rotation axis. The manual workstation has been designed for both benchtop or cart-mounted operation and the wide upward opening door allows easy loading and unloading.
www.fobalaser.com

CNC CAM GRINDING

Piper Cams grinding

Long time camshaft specialists Piper Cams have recently upgraded their manufacturing capacity to allow them to produce some of the most complex cam profiles currently available.

This is thanks to the addition of a Berco Lynx 2000 grinding machine, the same used by several F1 teams, which is capable of producing negative radius cam profiles down to 15mm. With the addition of the new machine, which they believe to be the only of its type commercially available in the UK, the company will be able to produce bespoke and small batch runs of cams featuring even the most complicated geometries.
www.pipercams.co.uk

SENSORS

Kistler KiTorq torque sensor upgrades

The Kistler KiTorq torque sensor system is now available with Profibus, Profinet CANopen, Ethercat and EthernetIP interfaces in addition to the analog/frequency, USB and RS-232 interfaces.

The new stator is also now fully compatible with all KiTorq type 4550A rotors. These communication options allow the KiTorq system to be integrated directly into the user's test environment through the fieldbus interfaces. This saves time during installation and eliminates the cost of additional equipment to convert measured data, making the new stator more cost-effective for test stand design, installation and operation in applications for electric motor, internal combustion engine, transmissions, pump and compressor testing.

The new stator can be used with any KiTorq rotor of the same speed rating and will automatically recognise the rotor measuring range. With rotors available with seven measuring ranges from 100-5000Nm, hardware investment is minimised as one stator may be used with rotors of differing ranges for different applications. Installation is also simplified by the contactless, digital telemetry that eliminates the need for an antenna ring while maintaining the excellent signal bandwidth of 10kHz and accuracy of better than 0.05 per cent of range.

A speed measurement of 60 pulses per revolution is integrated in the standard system.
www.kistler.com

How to optimise your visit to the Autosport trade show

You have a business looking to expand, and you've made the great decision to attend the Autosport International Engineering show. Now it's time to plan ahead, says Tony Tobias

Whether you are an exhibitor or a visitor, trade exhibitions and consumer shows are great places to network and forge good business relationships. Face-to-face contact with customers and suppliers is vital and can make the wheels of your business turn more smoothly. You can meet new prospects and find new products, materials and technologies that will enable you to keep ahead of your competitors.

PLANNING YOUR VISIT TO AN EXHIBITION

One of the main benefits of attending an exhibition is that you can meet large numbers of useful people - all in one place. This will save hours of travelling to different companies, and so it is the most cost-effective way of locating new suppliers.

Trade show visitors always need to plan ahead to make the most of these opportunities. It's worth setting up appointments in advance so that you don't waste too much time browsing and talking to people you already know. It's vital that you focus on meeting the most useful people for your business.

To find out more about events that could help your business, contact the MIA, which has a presence at most major motorsport exhibitions both domestic and worldwide. It's also always well worth talking to your customers about which events they attend and why.

Before you choose which event to attend, you must work out what type of people you want to meet. Exhibition organisers such as Autosport International and PRI in America can give you detailed information about both the exhibitors and the visitors that come to their event. Think about the kind of products and services you are interested in to ensure that the event has the right type of exhibitors.

There will be opportunities to network with other visitors. This can be very valuable. The organisers can provide detailed information about the type of people who attend their show including their business activity, their job titles and their spending power.

OPPORTUNITIES FOR VISITORS

Exhibitions and conferences provide the chance to meet suppliers, check out new developments and to keep a close eye on your competition. You can get your hands on new products, attend demonstrations and compare features and prices. At the same time, you'll be able to meet exhibitors and ask them detailed questions.

Don't leave your meetings to chance. Make prior contact with the key people you want to see, such as customers, prospects and suppliers. Make arrangements to meet and - crucially - ensure that you have their mobile telephone numbers to hand.

Do your own research before an event so that you are well prepared for your meetings. Take plenty of business cards, for example. That said, if you run out at many exhibitions there are suppliers that can print your cards in a few minutes.

And - obviously - remember to take any literature you want to give out.

NETWORKING POTENTIAL

Make time to attend relevant events that are running alongside the show. Speeches by important industry figures, workshops, seminars and panel discussions can be informative and attract many of the key players in a sector. Again, the MIA can supply you with details of any events at the exhibition that they feel will be of interest to you.

These events are ideal environments for networking. Introduce yourself and your company – everyone is wearing a badge and is there to talk business. By taking the initiative, you can promote yourself and your business and make valuable contacts. A good approach is to get invited to receptions and hospitality suites.

To get the most out of exhibition attendance, it is worth setting specific targets so you can measure the success of the exhibition after the event.

AFTER THE SHOW

Make certain you collect cards and literature, so you can follow up on meetings and contacts that you have made at the show.

The MIA referred to in this editorial is the Motorsport Industry Association based in the UK.

For more information on how to exhibit at Autosport International, contact the head of business development, Tony Tobias: **tony.tobias@haymarket.com**

magazinesdownload.com

AUTOSPORT INTERNATIONAL
Engineering Show
9 - 10 January 2014 NEC Birmingham, UK
In association with Racecar engineering

ASI 2013 generates over a billion pounds in new business

This year's Autosport Engineering International show generated an estimated £1.07bn worth of new business within the motorsport and performance engineering industries.

The staggering figure represents a new record for the Birmingham, UK-based show, marking an increase of some £200m on the business that was the estimated result from the 2012 running of the event.

Over 28,000 motorsport professionals from 60 countries attended Autosport International (ASI) in 2013, while more than 600 leading manufacturers and suppliers from 18 countries displayed their hi-tech wares.

ASI returns to Birmingham's NEC on 9-12 January, with the opening two days dedicated to industry visitors, in the shape of Autosport Engineering in association with *Racecar Engineering* - the world's top motorsport tech title and the magazine you're now reading.

Ian France, ASI show director, said of the 2013 running of the event: 'Each and every year, we're proud to host industry leaders and to showcase and promote motorsport innovation. The feedback we received from exhibitors during this year's Autosport International was very positive. To see that translate into over £1bn in new business is outstanding for the entire industry and reinforces the UK's strength as a global hub for motorsport technology and suppliers from all over the world.

'The sales and new partnerships from the show will play a big role in motorsport in the coming years, both domestically and abroad,' France added.

In 2013, the show featured the launch of British sports and racecar manufacturer Radical's brand-new RXC, the MSV F4-013 for the new BRDC Formula 4 Championship and the Sin R1 sportscar project. Roger Green, marketing manager at Radical Sportscars, said of its own experiences at the show: 'We had a fantastic launch of our new car. It worked really well - there was a great buzz and we received lots of new enquiries.

'As an exhibition, Autosport International is a perfect fit for us, in both timing and audience. It's the only show we do full throttle as a company and we received excellent press coverage both prior to and after the event.'

Trade registration for ASI 2014 is now open. Tickets are available from £26, with discounts for group bookings. **To register call +44 (0)845-218 6012, or visit www.autosportinternational.com**

INTERNATIONAL MOTORSPORT
6 - 12 JANUARY 2014, UK
BUSINESS WEEK

International Motorsport Business Week (IMBW) will again bring the industry's key figures together in Birmingham on 6-12 January 2014. Now in its fourth year, IMBW will host a range of focused events to provide a week of extended networking and business opportunities, leading into Autosport International. **www.autosportinternational.com/trade**

Trade registration
Registration is now open for Europe's largest dedicated motorsport trade show, Autosport International 2014. Being held at Birmingham's NEC on 9-12 January, the event will again include two days dedicated to industry guests, Autosport Engineering in association with *Racecar Engineering*, on 9-10 January. Adult tickets are £26, with discounts available for group bookings. Register now at: **www.autosportinternational.com/trade**

WELCOME NEWCOMERS

The Autosport Engineering Show, held in conjunction with *Racecar Engineering* on 9-10 January in Hall 9 of National Exhibition Centre, Birmingham, has already attracted more than 110 companies to exhibit from around the world.

German Company ACTech GmbH are new to the show this year. The company is a leading supplier of rapid prototyping technology services. Their core competence is the production of castings for developmental purposes in the automotive industry, in addition to other sectors.

Also new to the show this year is American company Injen Technology Co Ltd, based in California and which for more than a decade has played a major role in the design and development of air intake systems.

Injen was born out of parent company RD Metal Works, which has been designing and manufacturing air intake kits for leading air filter and intake manufacturers since the mid-90s.

Companies that have signed up to exhibit at the 2014 show include:

ACTech GmbH, E740
Braille Battery UK, E160
Brown & Miller Racing Solutions, E1260
EOS Electro Optical System, E942
Goodridge Ltd, E262
Holinger Engineering, E240
Injen Technology Co Ltd, E241
Lane Electronics, E640
MaxParts Norma UK, E683
Nexus GB Ltd, E1032
ODU UK, E842
SPAL Automotive UK Ltd, E530
Stand 21 UK, E590
Tekdata Interconnections Ltd, E1046

F1 tyres: higher or lower?

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www.racecar-engineering.com

One of the major talking points at the launch of the Formula E series was the vision of low profile tyres on a single-seater. Immediately on the social networking sites, there were calls for Formula 1 to go the same way and – as far as Pirelli is concerned – it could do so. Why does Formula 1 have 13-inch rims, with large, bulbous tyres that bear no relation to anything else in racing, or on the road?

As Michelin explains in the Formula E feature in this magazine, low profile tyres are more efficient. So the losses in F1 would be huge and there should be an immediate call for change.

Actually, what if we are looking at it from the wrong perspective? For Formula 1 teams to adopt 18-inch rims, it would need a long lead-time, according to Pirelli boss, Paul Hembery. New suspension design, designed to soak up the bumps on the track and replace the damping that the F1 tyres provide, would be necessary. Also, Hembery points out, to go low profile would be to the detriment of Pirelli as it would rob the company of the valuable advertising space on the side of the tyre.

What really concerned him, though, was that 18-inch wheels are now commonplace on mid-range cars, such as the Volkswagen Golf. If Pirelli, or any other tyre manufacturer, really wanted to produce something that promoted a sporty message for Formula 1, it would need 20-inch wheels to make it even slightly relevant. Then, of course, you would need some cynical marketing ploy if you try to dupe the public into thinking that they could drive on a tyre that even vaguely resembled the F1 compound and structure.

Yet I think that Formula 1 has got it right, and that it is the production car industry, led by customers, that has left us with low profile tyres. In the UK, the roads are so badly maintained that it is not worth getting anything with sport suspension unless you know a good dentist. Our roads are so bad that Audi once sent its engineers over to the UK to investigate why there were so many complaints from the customer base about the ride of its cars. They discovered roads that were in abysmal condition, and since then, they have got a whole lot worse.

The American car industry famously produces softly sprung cars anyway, so low-profile makes no sense unless you really have sport in mind.

So, why the solution to spec up cars with low-profile tyres? Come to think of it, what's the point of running flat tyres? Drive over a nail, and there is no option to repair the tyre – you have to throw it away, it's expensive to replace, and the tyres do nothing to help the ride.

Does high profile really hurt the cornering ability of a car? Does Formula 1 really suffer on cornering speed? The downforces mean that the sidewalls must be stiff on the 13-inch rims, and that is not what you need on a road car. Yet we are not talking about introducing small tyres on a production car. We are talking about, perhaps, 17-inch rims with tyres to match.

Should we be looking at bringing back the Cars-style white wall tyres in NASCAR? What would an LMP1 car look like on high profile rims?

Clearly there would need to be a bit of development work to the Audis, Toyotas and Porsches to accommodate them, but if the trend for production cars led us back into a tyre that was suitable for our roads, we would all be turning to F1 for inspiration. And that's not something we can say every day.

EDITOR
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To subscribe to *Racecar Engineering*, go to www.racecar-engineering.com/subscribe or email racecar@servicehelpline.co.uk telephone +44 (0) 1795 419837

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